

ASSESSMENT OF SIGNIFICANT EXISTING AND PROPOSED RESIDENTIAL SOURCE SEPARATION PROGRAMS: A STATE OF THE ART STUDY

December 1979

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ASSESSMENT OF SIGNIFICANT
EXISTING AND PROPOSED
RESIDENTIAL SOURCE SEPARATION PROGRAMS:
A STATE OF THE ART STUDY

by JoAnn Opperman
for the
Waste Management Advisory Board
Ontario Ministry of the Environment

December 1979

The conclusions in this report represent only the views of the consultant and are not necessarily those of the Waste Management Advisory Board or the Ministry of the Environment.

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ABSTRACT

A state of the art study done by a researcher for the Ontario Waste Management Advisory Board, this report compiles information from a number of United States and Canadian residential source separation schemes. Evaluating the applicability of data for the Province of Ontario, the report summarizes trends in other jurisdictions at each stage of system design for source separation programs. Appended are outlines of specific programs. Annotated bibliography; references.

Key Words: Source Separation; Resource Recovery

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SECTION 1

INTRODUCTION1.1 Report Organization

After a statement of purposes and limits, summary and conclusions are provided for readers who require a less detailed account of this research. Next an overview portrays some of the larger economic, political and social factors which affect and logically precede the body of the report. The body of the report is a discussion of source separation system design components with special emphasis on questions posed by the Waste Management Advisory Board. At the end of each section, the applicability of trends in other jurisdictions to the situation in Ontario is assessed. Appendices contain a systematic comparison of specific source separation programs. Resource materials are appended for readers who wish to pursue the subject further.

1.2 Purpose of the Study

A compilation of information about significant existing and proposed residential source separation programs was undertaken early in 1978 for the Ontario Waste Management Advisory Board. A periodic state of the art study is essential for keeping such a Board up to date. Source separation is a waste management practice that appeared in the late nineteen sixties and has advanced considerably over the last eight years.

As Ontario has embarked upon a set of pilot schemes, a review of source separation programs in other jurisdictions is useful for comparison. Time-tested features of other programs might be applicable to Ontario. Innovative practices and streamlining attempts elsewhere could suggest new or expanded source separation designs here.

Of particular interest is what progress is being made in such areas as: methods of cost allocation; systems for rural areas or apartment complexes; home container provision; collection vehicle design; additions to conventionally collected recyclable fractions; administrative approaches; and marketing techniques.

1.3 Limits of the Study

A. Limits to the Terms of Reference:

An extensive literature search was carried out, and key persons responsible for source separation were contacted in the course of this research. It became

apparent that if a limited number of specific programs were outlined, then some of the most innovative and noteworthy aspects of source separation would remain uncovered. It was decided then, to summarize information about the general components of system design in the body of the report, and to append selected case histories.

B. Limits to Generalizations:

Every source separation program is tailored to fit local circumstances with resulting wide variations from program to program. Within each program, every component of system design is a function of one or a combination of other components. Consequently generalizations about overall source separation programs must be considered tentative. With the limited number of successful site-specific programs on stream, there is no typical program, and no exemplary model for replication. There is however, some consistency in the process of designing and implementing local source separation programs. Therefore this report emphasizes not only what is significant about programs but also how these decisions are made. The use of the "implementation mode" (how to) as well as the "descriptive mode" will be apparent in this report.

C. Limits to Data Gathering:

Mailed information requests in this research were beset by lag times of four to six weeks before responses were received. In every case, telephone follow-ups were necessary to acquire these responses and many promised written responses were never received. Among the resource persons and organizations contacted, different data gathering problems occurred.

Government officials at federal and state levels were overwhelmed with information requests and were preoccupied with other waste management issues. Repeated enquiries were necessary to acquire materials of disappointing quality. Consultants often had to obtain release from clients before sending certain materials. One U.S. consulting company has an obvious monopoly on source separation research and program design. As the company (SCS Engineers, Inc.) is nearly the only source of hard data, extensive use was made of their material, a bias which is reflected in this report.

Municipal officials were the most responsive contacts, but rigorous data were rarely available. Commercial haulers and private companies were not willing to reveal "trade secrets", especially cost-revenue data.

Several non-profit ecology groups would not discuss data without payment. For instance the Recycling Council of British Columbia refused to allow information on the significant Kelowna Recycling Society pilot program to be published without purchase.

Many volunteer or quasi-commercial ecology groups were so busy operating source separation programs that they had no time to collect data, record experiences or answer enquiries. Yet they all hoped to produce implementation manuals or case histories for the benefit of others and to fill information requests. One engineer remarked that it is dangerous to treat documented programs as significant, because the successful ones are, by definition, not written up!

Finally, the information of certain public interest group advocates of source separation was unreliable. In general, hard data and systematic information were scarce despite the almost universal recognition that cost data and procedures documentation would be essential for others who are planning programs or investigating the feasibility of source separation. This recognition of the value of documentation was always accompanied by cautions about transferring data and transplanting designs into other geographic areas.

(Note: Since most of the information in this research has been acquired from the United States, the 2000-pound ton forms the basis for most weight measures in this report, unless otherwise noted.)

SECTION 2

SUMMARY AND CONCLUSIONS2.1 Highlights--The State of the Art in Jurisdictions Outside of OntarioGeneral Conditions Favouring Source Separation:

Several general conditions appear to strongly favour source separation in the United States. Federal laws proscribing unsound waste disposal have forced all lower government levels to seek waste management alternatives. Domestic resource shortages have helped to make recycling a national economic strategy and source separation a matter of patriotism. Pulp shortages have stimulated the newspaper de-inking industry which, in turn, creates a demand for source separated newspaper. Political, environmental, and economic factors have stimulated the demand for waste aluminum and glass. The demand for high-revenue aluminum, in turn, makes multi-material source separation more attractive financially. Both heavy advocacy of source separation by national and local public interest groups, and numerous entrepreneurial source separation ventures are factors in the U.S. (Nevertheless source separation has become a topic of debate among opposing interest groups, some of whom promote mechanical material and energy recovery. Flow ordinances, enacted to guarantee inputs to mechanical plants, have cut source separation options in some localities.)

Administrative Approaches:

Innovative administration of source separation programs is marked by several trends including: increasing involvement of commercial refuse haulers in source separation; the evolution of ecology groups into non-profit source separation businesses; the tendency for public interest groups to carry out the publicity components of municipally-run source separation programs; the adoption of source separation programs as skill-building projects for social service agencies; and general use of the "social service labour pool" in source separation programs. Advancing the state of the art in program management, various studies on labour productivity indicate that collection labour factors deserve careful attention. It is generally acknowledged that crew sizes must be pared, labour intensive activities must be minimized (except where skill-building is a goal), volunteer labour must be assigned opportunity costs in economic evaluations, and personnel relations must be improved so that labour disputes will not arise over unfamiliar equipment and new responsibilities of workers.

Marketability of Materials:

Marketability of materials is associated with demand created by the significant newspaper de-inking industry,

by the export fibre market, by aluminum can manufacturers, and to a lesser but growing extent by the glass industry. In certain regions, demand is strong for unconventional materials due to markets for mixed paper, plastic, rubber tires, and reusable bottles. The west coast bottle washing is a significant innovation in creating demand for recovered, reusable bottles. Marketability is also marked by advances in the quality and quantity of materials supplied. Thus, the multi-material intermediate processors who upgrade materials, and the multi-material brokers who market for members or federated groups, are significant innovations. These intermediaries eliminate duplication of effort at the individual program level and provide buyers with high-quality materials and/or reliable supply. Marketability is also being advanced by more professional marketing procedures at the individual program level. Other marketing innovations include expansion to sales of recovered non-residential wastes, and establishment of outlets for reusable items, crafts, compost, and insulation.

Curbside Collection Vehicles:

As yet, no standard, tested, mass produced vehicle is available for source separate curbside collection. Collection vehicle design tends to be a site-specific exercise for source separation program planners. At least twelve program variables have been identified in this research as relevant to vehicle design on a program-by-program basis. Despite the lack of a specific vehicle, the state of the art has been advanced by several engineering studies which have established procedures for choosing the proper collection equipment under given circumstances; these studies also provide productivity and performance evaluations of certain equipment and equipment combinations. Some of the more innovative vehicle designs (with general applicability) are rack-fitted packers for newspaper collections, compartmentalized bucket-loading trucks and bin-toting container trains hauled by conventional trucks--both for multi-material collections, and one specially designed "Separated Discards Carrier" for concurrent collection of multi-material recyclables and refuse.

Rural Source Separation System Designs:

Among the various systems which exist for source separation in rural areas, several have achieved degrees of regionalization which suggest that rural programs can be viable, especially where conventional disposal alternatives are not available. The most significant examples hail from the U.S. northeast where small towns on a regional basis, have established collection centres to which residents and commercial haulers deliver both recyclable waste and disposable refuse.

Apartment Source Separation System Designs:

Despite the potential for large material quantities and

economies of scale in apartment source separation, few advances have been made in this field. Approaches include normal curbside collection of tenants' materials, satellite servicing of central drop-off containers, unit-by-unit collection, conventional dealer-superintendent arrangements, and elaborate systems for transferring material from refuse rooms to pickup vehicle via elevator on specified days. Storage constraints and tenant attitudes are acknowledged as major barriers, but small complexes and buildings in which newspaper is not allowed down refuse chutes, indicate potential situations for source separation.

Factors Associated with High Participation in Programs:

The effectiveness of source separation as a waste management option depends on public participation. This research pinpoints various factors that are thought or known to be associated with high participation, or recovery and diverted disposal--two other measures of program success. Factors conducive to participation include community characteristics such as high socioeconomic status; the presence of public interest groups which draw attention to waste issues; small community size, which is more amenable to word-of-mouth communication about source separation than is large community size; and the public perception of waste as a high profile issue. Program duration, and the pickup (curbside) rather than drop-off (delivery) mode of collection, are known to be conducive to high participation. Reliability of collection service is of paramount importance, since vigorous publicity can be undermined by such irregularities as missed pickups, or temporary cancellation of program due to bad weather or market fluctuations. Further research is acknowledged to be needed on how several curbside collection considerations affect participation. These considerations are: weekly pickup vs. less frequent pickup; simultaneous collection of all recyclable fractions vs. separate collections for each fraction; same-day collection vs. different-day collection of refuse and recyclables. (Current thinking favours the first option in each consideration, but in each case, trade-offs between participation and cost/collection efficiency may be involved.) Other factors thought to be associated with participation include the association of the program with broad social goals (e.g. when the "rehabilitative" labour force is employed), mandatory laws, and financial penalties imposed for waste generation. The state of the art in promoting source separation has been advanced considerably by several studies on effective publicity techniques.

Intermediate Processing:

One of the most significant advances identified in this research is the appearance of multi-material "intermediate processors" in U.S. coastal areas. As entrepreneurial ventures serving source separation programs on a regional basis, the four known multi-material dealers acquire, process (upgrade and reduce the volume of materials), and

deliver materials to buyers. Their processing activities generally eliminate the need for householder material preparation and in-program processing which can be costly on a small-volume basis. Generally, because of the transportation services and/or central locations of the intermediate processors, source separation programs can make multi-material shipments to closer points at more frequent intervals, compared to storing materials longer, and shipping (at less frequent intervals) individual materials to distant markets. Since intermediate processors provide marketing services for a number of source separation programs, individual programs market several fractions to the regional buyers, and these buyers negotiate higher unit prices, from user industries, with the pooled volumes. In addition to these transportation (from suppliers to plant and from plant to buyers), processing, and marketing services, one intermediate processor proposes to offer a variety of legal, educational, staff training, R & D, equipment repair, publishing, and other services to its supplier programs. The systems approach, evident in the activities of the intermediate processors, offers economies of scale which are not attained by individual source separation programs.

Economics of Source Separation:

Source separation generally continues to be economically marginal when looked at in a conventional business sense and in isolation from overall waste management; however, when source separation is evaluated in relation to refuse collection and disposal, the economic picture improves. Employing both full and actual cost allocation approaches is recommended by the U.S. Environmental Protection Agency for economic evaluations of source separation programs. Various kinds of subsidies, mainly for program design, equipment purchase, operating labour, and program evaluation, are stimulating the establishment of programs. Considering the lack of hard cost data available for source separation programs, the several recent and rigorous economic evaluations of key programs are a significant contribution to the state of the art.

Laws Mandating Householder Participation in Programs:

Opponents point to the lack of public acceptance and enforceability of legally prescribed source separation, but proponents claim that obligatory source separation increases the technical efficiency and economic effectiveness of source separation programs. The position of the U.S. EPA is that mandatory ordinances can be enacted to bolster a program under three conditions--where there are guaranteed markets for materials, where vigorous program promotion is carried out, and where convenient, reliable collection is maintained. A significant legal variation is the concept of mandatory participation for towns in regional waste management plans which include source separation.

Special Containers for Source Separation:

Not considered essential by most of the persons contacted

in this research, special containers are thought of as costly, but as having advantages in terms of convenient materials storage, efficient materials collection, and especially effective program promotion when containers are set at curbside.

2.2 Summary of Report Sections and Conclusions about the Applicability of Experiences Elsewhere to the Situation in Ontario

2.2.1 Preliminary Considerations (Section 3)

In this report on significant source separation programs, most examples have been drawn from the United States where there are different political, social, and economic circumstances. Both as a caution against transplanting U.S. experience to the Ontario situation, and as an illustration of conditions favouring source separation, the following trends are noted in section 3:

- Source separation is stimulated by various forms of federal and local laws which proscribe unsound disposal practices and promote the implementation of alternatives. The introduction of these laws has helped to make waste disposal a publicly perceived issue.
- In light of resource shortage forecasts, recycling has become a national economic strategy and a matter of patriotism.
- The prevalence of valuable aluminum in the residential waste stream adds to the financial attractiveness of source separation.
- In certain regions, the marketability of newspaper is guaranteed due to the existence of the newspaper de-inking industry; however, glass is more difficult to market.
- The growth of an intermediate processing industry indicates a shift toward a systems approach in certain regions where multi-material dealers process and market materials from feeder programs.
- Heavy organizational advocacy of source separation, and numerous entrepreneurial ventures in the field, are increasing the profile of source separation as a waste management option.

A debate exists in the U.S. about the compatibility of source reduction, source separation, and mechanical materials/energy recovery. Subsection 3.3 outlines the proponents and arguments on each side. While a case can be made for combining the options in a total waste management package, a full commitment to the first and/or third option has consequences for source separation. In the U.S., source separation is perceived to be threatened by the large throughputs required to run mechanical recovery plants on a feasible cost per ton basis. Some cities have adopted flow ordinances which, in guaranteeing refuse levels for plants, have cut the other two options. Nevertheless, source separation is at present incapable of coping with the massive amounts of urban wastes that mechanical plants, once technically perfected, can potentially handle. The challenge to Ontario policy makers is to combine these approaches, and design cost-sharing mechanisms that neither foreclose low-technology options, nor render recovery plants unfeasible, when waste is reduced, or diverted through source separation.

2.2.2 Sponsorship, Administration, and Labour in Source Separation Programs (Section 5)

The material contained in this section treats the social structural and human resource aspects of source separation programs. Public, private, and volunteer sector roles in program design and operation are described, along with administrative innovations in the field, and labour force considerations. The following trends in jurisdictions outside of Ontario are noted as significant:

- Source separation programs involve a rich panorama of organizations, including various government levels, private haulers and multi-national waste management companies, secondary materials users and their associations, consulting companies, non-profit source separation companies evolved from ecology groups, intermediate processors, traditional dealers and brokers, national public interest groups, local ecology groups, service clubs and charities, coalitions of federated groups, and social service agencies.
- Private garbage haulers are playing a greater role in source separation. This is partly due to the fact that municipalities are contracting out more waste management tasks to private enterprise, perceived as better able to run efficient operations. The trend is also partly due to the fact that U.S. markets are more secure; therefore, source separation is attracting private enterprise.
- The cogency of finding sound alternatives to illegal disposal facilities unites public, private and volunteer sectors in national, regional and local problem-solving activities. There are political and practical advantages in this pooling of expertise. The role of national public interest groups in advocating source separation and the role of local public interest groups in performing program promotional tasks, are cases in point.
- Innovative use of the social service labour pool is on the increase. Funding programs for job-creation assign labourers to ongoing source separation programs, and fund agencies who themselves operate programs. The social service labour pool is comprised of delinquent youths, racial minorities, legal offenders, and handicapped persons. Several advantages are associated with the use of the social service job sector:
 - "free" or low cost labour;
 - higher public participation when external ecological benefits are broadened to include rehabilitation of problem social groups as additional advantages of source separation;
 - job-creation spill-over for the individuals "employed" and for countering critics of environmental projects; and
 - a broadened funding base for financing source separation.
- Evolving from earlier ecology groups, a new non-profit source separation business sector is emerging. These

businesses still wear some of the marks of their infancy (dependency on grants, reduction/reuse philosophy, interest in unprofitable fractions). In some locations, their existence is perceived as a threat by waste haulers, secondary materials dealers, and proponents of mechanical recovery.

The above trends elsewhere have consequences for Ontario government policy-makers and funders. At the current stage in the development of source separation in North America, it is not clear whether source separation should be considered a marginal business, a municipal service, an ecology project, a fund-raising tool, or a rehabilitative strategy. The number of goals and practitioners associated with source separation could be an advantage--many different segments of society working to solve waste management problems. The many goals and practitioners could also prevent source separation from being perceived by the public as a serious waste management option. In order to increase the legitimacy of source separation, government support to operators of programs, could have at least four conditions. Programs would need to be well managed; have a majority of paid staff on at least minimum wage; maintain records on data collection; and carry out, or plan to carry out multi-material collection. Programs would also need to be committed to institutionalizing source separation locally and cooperating in a province-wide system.

In addition to the initiators and administrative operators of source separation programs outside of Ontario, this section looks at the "front-line" collection workers in programs. Aside from remarks already made about volunteer and social service labour, several conclusions can be drawn from the small number of available engineering studies which analyze labour used in source separation programs:

- Labour requirements must be determined with regard for other components of program design: number and kinds of fractions; number and kinds of activities (collection, transfer, processing, storage, hauling to market, etc.); type of program (curbside collection or drop-off centre); equipment design (collection vehicles, balers, crushers, etc.); availability of reserve/borrowed/volunteer labour and labour subsidies.
- Crews on both conventional rear-loading packers and compartmentalized vehicles performing separate collection can be pared to two or even one person.
- Programs which process materials incur higher labour costs for these additional activities. Such costs may or may not be off-set by higher revenues for upgrading materials, or by lower hauling costs resulting from volume reduction.
- In government funded source separation programs, all labour whether paid, volunteer, or borrowed from refuse collection, should be assigned costs. Labour productivity data (person-hours per ton

recovered) should also be recorded. These two techniques would be helpful in program comparison and evaluation.

- Source separation planners must be sensitive to the resistance of organized labour and individual workers to source separation programs. New and modified collection vehicles, additional collection responsibilities, and public complaints directed at crews in programs, have caused labour problems which, in turn, have resulted in less reliable separate collection and depressed participation. Front-line workers should be consulted, educated, and motivated.

2.2.3. Marketing (Section 6)

The section on marketing in other jurisdictions reviews developments aiding the marketability of source separated materials. These developments include increased demand for materials, improvements in the quality and quantity of materials supplied, and more professional marketing techniques employed by program operators and intermediaries. The following trends are noted as significant:

- The newspaper recycling industry boosts demand for newspaper in regions where the several de-inking plants are located.
- Regional variations in materials marketability exist as in the following examples: Mixed paper grades are acceptable in areas where there are building materials manufacturers. The Far East export market is available to west coast source separation programs. Waste glass demand has been stimulated by government pressure on the glass industry to boost cullet use as an alternative to installing pollution control equipment. Local breweries provide a market for refillable bottles extracted from the recyclables stream. The new west coast reusable bottle washing industry has created a demand for reusable bottles, formerly considered recyclable. A west coast toy manufacturer has created demand for waste plastic containers. The demand for returnable aluminum cans, prominent in the U.S. waste stream, is strong. Sale of compost to collection centre patrons is slated for several New England rural programs. Waste oil and recappable tires are two other materials for which demand appears to be increasing.
- Improvements in the reliability of supply are occurring through innovative dealing and brokering structures. The northeast U.S. "intermediate processors" are multi-material dealers. The various forms of collective or cooperative marketing agencies on the west coast are multi-material brokers. These new dealers and brokers are stimulating supply by absorbing the burden of marketing previously performed by individual source separation programs; by rerouting materials according to market demand and therefore buffering individual programs

from fluctuations in price; and by controlling a high volume of supply and therefore improving the bargaining position of individual programs which, with their small volumes, would have difficulty in securing markets. In other words, the existence of this form of dealing and brokering marks the appearance of a "marketing service sector" which helps to sustain supply mechanisms. This quantity of pooled supply, and especially the improved quality of processed material supplied, in turn, help to strengthen demand.

- The establishment of resale outlets attached to source separation program sites is a form of "vertical integration" in which programs market materials directly to the public.
- Demand for mixed types of source separated materials has been made possible by "intermediate processors" which separate and resell the various components. Thus, in certain coastal regions of the U.S., fully or partially "comingled" can/glass/paper is marketable for source separation programs.
- Another related development on the supply side is the increasing interest of residential source separation programs in commercial, institutional, and industrial waste materials. Office paper, retail corrugated board, and restaurant glass are, in some cases, collected and marketed. These other materials are often cleaner as collected and can attract higher revenues than the conventional residential fractions. Thus, the marketability of these non-residential materials provides a subsidy and helps to sustain the supply mechanisms in general.
- In addition to the advances made by the "service sector" referred to above, marketability has been advanced by an emphasis on systematic marketing procedures. Significant programs are characterized by a marketing stage which includes estimation of recyclables generation, economic hauling modes and distances, and reliability of demand, as well as negotiation of contracts--all businesslike techniques not associated with earlier source separation history.

Advances in marketing elsewhere suggest that, in Ontario, consideration could be given to the following:

- Developing financial incentive and/or subsidy schemes for industries which can begin to consume or expand consumption of secondary materials.
- Encouraging the establishment of resale outlets, compost farms, refurbishing workshops, and product reprocessing enterprises, where these can be locally appropriate when attached to source separation programs.
- Supporting a "materials marketing service sector" which can perform marketing, transportation, and processing services for source separation programs on a regional basis, thus pooling small volumes for more reliable supply and more secure demand.
- Encouraging the addition of marketable, non-residential fibres and glass to fractions collected by primarily

residential source separation programs.

- Promoting professional, business-like marketing procedures to be practiced by program operators.
- Supporting research on economical, regional transportation systems for hauling recovered materials to non-local markets.

Certain significant U.S. marketing advances do not appear to warrant further consideration for Ontario because of different domestic circumstances; consequently, marketability of aluminum cans, comingled materials, and reusable glass is not considered to be applicable if trends are to be maintained in the proscription on aluminum beverage containers, the tradition of householder separation of recyclable components in existing multi-material programs, and the principle of consumer return of refillable milk, beer, and pop containers to the point of purchase.

2.2.4 Vehicles Employed in Source Separation Programs, and Related Key Collection Decisions (Section 7)

Although vehicles are employed at several stages of the materials flow (collection, handling, hauling to market) in source separation programs, this section concentrates on vehicles employed in curbside collection. Collection efficiency is key to program economics; therefore, in significant programs, vehicle choices are made with a view to efficient loading and off-loading of materials.

Vehicles currently employed in source separate collection include unmodified standard trucks, modified trucks, special combinations of trucks and trailers, and specially designed new equipment such as compartmentalized bucket-loading trucks for two or three categories of recyclables (the design is based on that of a bucket-loading rendering vehicle), and the "Separated Discards Carrier" with bucket-loading compartments for glass and cans, racks for newspaper, and a refuse packing body.

Characteristic of the advancing state of the art and of the more recent concern over multi-material collection efficiency, a number of engineering studies have been carried out to determine the appropriate truck for a given program or to determine the circumstances under which one vehicle type is more efficient than another. These engineering studies are summarized in this section. There are strong indications that concurrent pickup of several recyclable fractions (single pass system) is more economical than repeating collection passes for each fraction (multiple pass system) in multi-material curbside programs.

Despite the attempts at adapting, combining, and re-designing collection equipment in other jurisdictions, there are no known, mass produced, or "bug free" special vehicles in use at the present time. This lack of a

standard, tested vehicle is not seen as a critical problem by people in the field because site-specific considerations form the bases for choices of appropriate vehicles; that is, curbside collection vehicle designs are chosen according to parameters defined by other source separation program variables such as the following:

- Number and kind of fractions collected
- Material preparation requirements of buyer and/or the program's resources for processing
- Distance from collection route to central program handling site or buyer site
- Quantities collected as determined by local materials generation, composition, and recovery, participation, size of collection area, and frequency of collection
- Financial resources as determined by fees, revenues, disposal credits, subsidies, demonstration grants, and methods of cost allocation
- Stage in program life cycle from pilot to full scale operation
- Type of program sponsorship: municipal, commercial, third sector
- Integration of recyclable and refuse collections
- Single or multiple pass collection approach
- Community and geographic characteristics: weather, terrain, housing density
- Compatibility with off-loading facilities at central program handling site or buyer site
- Compatibility with labour requirements and existing equipment pools.

Applying advances in the state of the art elsewhere to the situation in Ontario, several conclusions can be drawn:

- Planners of programs should be encouraged to take a businesslike approach to choice of vehicle options. The vehicle choice should be rationalized according to other program design requirements as listed above.
- The three most innovative, yet relevant, vehicle concepts identified in this assessment could be tested in existing or future Ontario source separation programs. These three concepts are: the compartmentalized truck, the container train, and the integrated refuse-recyclables carrier. Capital equipment cost would likely require government subsidy. One such initiative is underway in Toronto where a federal subsidy is enabling two companies (a source separation program and a truck body manufacturer) to jointly develop a multi-material source separate collection vehicle suitable for small Ontario municipalities. Test results, when available for this vehicle, should be examined by Ontario government officials.
- In addition to technical vehicle design, experience elsewhere indicates that collection efficiency is also affected by other considerations such as crew size (i.e. one- or two-person crews are less costly); loading methods (e.g. pitching is faster than stacking); worker familiarity with and acceptance of equipment (e.g. trailers

are not popular among collectors); route design (e.g. all right-hand turns reduce travel time); collection day (i.e. recyclables collection on a non-refuse collection day eliminates collector confusion as to what is set out in containers); and so forth. It would be useful if these and other streamlining cues were compiled and made available to Ontario program planners and operators.

2.2.5 Source Separation System Designs for Rural Areas: Toward Regionalization (Section 8)

In this section, three rural U.S. source separation program models are examined: mobile drop-off centres run by non-profit businesses, a door-to-door commercial pickup service, and collection centres for recyclables run by local towns. In the latter system, reclamation is integrated with overall waste management in contrast to the former two models. A satellite operation, proposed for a U.S. urban area, is also illustrated because it is applicable to rural areas.

Although hard cost data for the models examined are limited, it appears that the regionalization inherent in some programs elsewhere may have applicability to Ontario. Aspects of programs which appear to be efficient include: the substation which is serviced by central site transport and marketing facilities in Arcata, California; the processing facilities shared by New England towns which have adapted aspects of the Nottingham prototype; the depot service vehicle and central baling activities proposed for Lincoln County, Maine; and the satellite depot network feeding into a central processing facility as proposed in Connecticut. Aspects of programs which appear to be less efficient are the manned mobile depots operated in Arcata, the unmanned mobile depots maintained by Arrowhead in Duluth, Minnesota, and the door-to-door collection service offered in the Vershire Plan. In the apparently more efficient operations, regionalization, with its economies of scale, can help to overcome the rural, low throughput-expensive haul problem by reducing costs.

Aggregating the operations and aspirations of (existing and proposed) rural and non-rural regional source separation programs elsewhere, it is possible to outline a comprehensive rural regional source separation system. Such a system could have a regional facility fed by the following suppliers and sources:

- individual householders;
- individual drop-off sites;
- several drop-off sites serviced by a centrally dispatched satellite collection vehicle;
- fund-raising groups;
- commercial generators of food, fibre, and glass wastes;
- industrial generators of specific wastes.

The central services offered by the facility could include both "hard" technical services, and "soft" administrative services. The hard services could include:

- upgrading and volume reduction (bale, crush, flatten, sort, remove contaminants);
- storage and warehousing;
- transportation to market and from satellites.

The soft services, performed for the downward linkage (including collection centre substations which evolve into processing facilities, and perform their own hard services), could include:

- marketing;
- haul route organization;
- volume purchasing and servicing of equipment;
- payments for materials received;
- feasibility research related to the evolution of substations into processing facilities;
- program planning and design;
- personnel training;
- public relations and public education;
- publishing of promotional/educational materials
- financial planning, accounting, and legal activities;
- R & D

Central services could also include refuse-related activities, i.e. transfer of refuse residual to land-fill, incineration of waste to heat processing plant and other site buildings. The on-site business spin-offs at such a central facility could include:

- resale store outlet, or free waste exchange;
- compost farm;
- confidential records shredding;
- reusable bottle washing;
- craft, repair, refinishing workshops;
- cellulose insulation manufacturing.

The outputs of such a facility could therefore include:

- refillable/reusable glass containers;
- compost;
- refurbished furniture, appliances, clothing, toys;
- recyclable/reusable materials: corrugated board, newspaper, fine paper, metal, rubber tires, waste oil, and rags, to local and regional markets;
- other reusable goods, e.g. egg cartons, plastic tubs, paper bags, and baskets, for local merchants.

Further research would be required to establish the financial, management, site design, equipment, staffing, phasing, and location requirements for such a facility. Although not all of the above activities may be applicable for Ontario, or be viable in rural Ontario, the concept deserves further consideration, particularly for urban areas without local markets.

2.2.6 Source Separation in Apartments: Systems Designed for High Population Density Situations (Section 9)

Examination of source separation programs designed for apartment buildings indicates the following trends:

- Curbside paper set-outs, and centrally stacked paper in refuse areas, are picked up as part of municipal paper collections.
- Special paper collection arrangements are made between apartment superintendents, or tenants' organizations, and paper buyers.
- Pickup programs for paper and other recyclables are sponsored by ecology groups, social agencies, and, on a less regular basis, by fund-raising organizations.
- For fund-raiser and superintendent-type schemes, where the motivation is profit, reclamation is dependent on market prices; consequently, programs in the municipal and non-profit categories are more reliable. (Apartment buildings are serviced along with other sources, and tenants, rather than the superintendents, are responsible for preparation and set-out.)
- Operating approaches include normal curbside collection of tenants' materials, satellite servicing of central drop-off containers, unit-by-unit collection, and more complicated systems for transferring material from refuse rooms to pickup vehicle via elevator on specified days.

Conditions influencing the current feasibility of apartment source separation are building size and existing refuse handling practices. Small buildings with low-rise construction are more likely to require tenant refuse disposal, without intervening chutes or superintendents. Thus, convenient drop-off points for recyclables can be placed near refuse disposal points. Where bottles and newspaper cannot be put down refuse chutes, the opportunity for marketing pre-separated materials is excellent.

Elsewhere, despite cynicism over some failed apartment programs, there is still interest on the part of government and corporate officials to take advantage of the economies of scale in multiple dwellings. Development of specialized recyclables handling equipment, and modification of existing facilities for source separation, are not seen as essential. Drums for small buildings and for satellite stations, and conventional vans and packers are being used for collection. There are physical storage constraints in apartment buildings, and existing facilities in apartment buildings are not designed for segregated materials handling, but the chief concern is human motivation--attracting the cooperation of building management and participation of tenants.

Based on information from other jurisdictions and from limited examples in Toronto, the following types of actions could be taken:

- Discussion could be initiated with government housing authorities which are responsible for building design standards and funding (OHC, CMHC) in order to address the problem of storage space for recyclables in multiple dwellings. Storage problems arise with respect to

individual units, to floor space in refuse rooms, and to central wastes handling areas.

- Discussion could be started with associations related to apartment building design (architects, developers). Despite high costs for open space and storage space in urban structures, an appeal could be made on the basis of savings in diverted disposal for building management where reclamation is practiced. Cost data on additional chutes could be compiled.

- Investigation could be made of Swedish social and mechanical techniques used in apartment buildings, as segregation of waste paper has been made a legal obligation of both households and municipalities throughout that country.

- While there is no assurance that techniques which work in one building are transferable to other buildings, there is enough general knowledge of system design (as outlined in this section) for the production of a guide that outlines steps for starting and maintaining an apartment source separation program. Such a guide or manual could be produced for public enquiries and include basic principles for marketing and publicity, in addition to operating cues.

- Some form of financial incentive or subsidy could be awarded to an existing source separation program(s) for purposes of including an apartment building test component in collection operations.

2.2.7 Source Separate Materials Processing (Section 10)

In this section, processing stages, activities, and purposes are examined for source separation programs in jurisdictions outside of Ontario. Processing includes material upgrading and volume reduction. Regarding its stages, processing can occur in the household, on a curbside collection vehicle to a limited extent, at a central program site (where materials are off-loaded by individual patrons, curbside collection vehicles, or vehicles which service other collection sites), at the site of a multi-material intermediate processor (where in existence), and at the site of a conventional single-material dealer/processor. The specifications and distances of secondary materials users determine the need for processing activities at earlier stages in the materials flow.

Generally, processing at later stages in the materials flow reduces the need for processing at earlier stages, but important trade-offs are involved. If householders are to be confronted with minimal inconvenience, then processing can either be performed at central program sites or later, by intermediaries. In-program processing is costly but brings maximum revenue from final buyers of materials. Intermediate processing obviates the need for in-program processing and therefore saves source separation program costs but results in lower revenues paid to programs by intermediaries.

Generally, in both single-material newspaper collection programs across the continent, and in multi-material programs in the U.S. northeast, source separation programs are opting for lower revenues paid by intermediary paperstock dealers and multi-material intermediate processors, in return for processing services which reduce processing activities at central program sites and at the household level. The resulting convenience to householders and therefore assumed higher recovery, and the elimination of in-program processing costs, are considered to be worth the loss of maximum revenues for the individual source separation programs.

The four U.S. "intermediate processors," whose operations are detailed in this section, are highlighted as a significant contribution to source separation. As a group, these entrepreneurial operations are able to meet the specifications of materials users, and are reducing the need for processing at earlier stages in the materials flow; therefore, they are helping to sustain and increase the number of source separation programs in operation, especially in the U.S. northeast where the glass industry resists accepting unprocessed, post-consumer waste glass. Generally, the intermediate processors offer the following advantages:

- Little or no material preparation is required of householders, and little or no upgrading or volume reduction need be performed by source separation programs.
- Transportation services are either provided or arranged for materials being moved from source separation program sites to processing facilities; therefore, programs can save storage space/costs and shipping costs by shipping to one buyer instead of several buyers and by shipping to closer points instead of distant points.
- Marketing services are provided for a number of source separation programs; therefore, individual programs can market all or most fractions to one buyer and the buyer can negotiate a higher unit price, from user industries, with the pooled volume.
- In the case of glass in the northeast U.S., the intermediate processors provide a glass market which would not otherwise exist.

In the northeast and west, processing is also carried out at source separation program sites where intermediate processors are not available, or for various reasons, not utilized. The reasons for processing include a desire to: save storage space, save hauling costs, secure markets, obtain higher revenues from materials buyers, make source separation more convenient for householders, eliminate the need for additional compartments in curbside collection vehicles, and eliminate the need for quality control by collection vehicle staff and collection centre patrons. Nevertheless the cost of processing small volumes of recyclables can

off-set the revenues gained or savings accrued by the various labour intensive and mechanical methods cited as processing activities in this section. The lack of hard cost data for in-program processing activities inhibits a meaningful evaluation of the cost-effectiveness of processing at the central site level. (Cost data supplied by intermediate processors indicate that, with capital equipment and operating costs of \$10 to \$30 per ton, their operations are at least marginally cost-effective depending on revenues achieved.)

Curbside collection vehicle constraints are found to determine the need for in-program or intermediate processing under certain market conditions, because of the need to reduce segregation responsibilities of householder participants and collection staff. For example, efficient multi-material curbside collection must minimize the number of curbside set-out containers, and curbside collection vehicle compartments or number of curbside passes required for collection; thus, where no markets exist for colour mixed glass, it is necessary to collect glass that is colour mixed and then separate colours at a later stage in the materials flow.

Despite the fact that glass/cans intermediate processing and in-program processing techniques have advanced the state of the art in source separation elsewhere, these experiences have limited applicability for Ontario. Most processing elsewhere is in response to:

- The resistance of the glass industry toward accepting glass that is not in kiln-ready particles or colour separated.
 - The prevalence of aluminum beverage cans in the residential waste stream and the high revenue associated with aluminum cans when separated from ferrous metal.
 - The heavy concentration of multi-material source separation programs on the east and west coasts where public enthusiasm for "recycling" and public recognition of the waste disposal crisis prevail.
 - The tradition of comingling (glass/cans or paper/glass/cans) that has been established in certain regions.
- (Few source separation programs, and only one out of four of the intermediate processors, in the U.S. bale fibres, due to vigorous conventional dealer activity in supplying the newspaper recycling industry and the export market.)

In Ontario, the need for glass upgrading may not be necessary if glass manufacturers pursue plans for a glass beneficiation plant and pay fair prices for colour mixed, metal-contaminated glass. Here, the need for ferrous-aluminum separation is not relevant, due to legislation proscribing aluminum beverage containers. Here, waste residential materials recovery does not yet enjoy equal priority status with conventional refuse disposal. In Ontario, comingling of several materials has no precedent in multi-material collection

programs (few multi-material curbside programs exist.) These domestic factors mitigate the applicability of U.S. in-program and intermediate processing experiences.

Nevertheless, the concept of the intermediate processing facility could be applied, with appropriate modifications, to the Ontario situation. Volume reduction of glass and "tin" cans at regional processing facilities, fed by individual source separation programs, could make a contribution to economical, bulk shipping of materials. It may be advisable for Ontario source separation programs, through regional facilities, to gear up for fibre baling in order to supply distant paper mills, in addition to local cellulosic insulation manufacturers whose demand currently fluctuates seasonally and whose demand may greatly slacken in future.

As an implemented concept, the intermediate processing facility could therefore help Ontario source separation programs to meet user industry specifications and could contribute to storage/shipping economies--both through technical "hardware" means. Also, the concept could be applied to the provision of legal, accounting, education, marketing, and other "software" services currently carried out and duplicated by individual programs in various Ontario regions. Regionalization of services is also discussed in section 8 with regard to rural systems and in section 6 with regard to marketing. Further investigation should be undertaken on regional processing facilities appropriate for Ontario.

2.2.8 Participation in Source Separation Programs (Section 11)

Motivating householders to participate in collection programs is key if source separation is to be an effective waste management option. It is the participants who contribute the materials to be recovered, and diverted from disposal. This section concentrates on the circumstances under which high participation can be achieved. In jurisdictions outside of Ontario, high participation (where participation data are lacking, recovery or diverted disposal data sometimes exist) is found to depend on community characteristics, on source separation program design aspects, and on effective public education measures.

The community characteristics which are thought or known to be conducive to participation are: high socioeconomic status; the presence of public interest groups which raise public awareness of issues; smaller community size; and the existence of publicly perceived, high profile disposal issues (problems with site availability and costs). Design components of the source separation system are important determinants of participation. The following summary lists the factors which are thought

or known to be conducive to participation because they either increase the convenience of source separation or help it to become a household habit:

- Comingling of several fractions, at least glass/cans, by householder.
- Washing, contaminant removal, and flattening made unnecessary for cans and glass.
- Curbside collection rather than drop-off centres.
- Weekly pickup as opposed to less frequent curbside collection (requires further confirmation; some data indicate that recovery, rather than participation, is reduced with less frequent collection).
- All fractions picked up simultaneously in multi-material programs as opposed to more confusing collection schedules (requires further confirmation).
- Recyclables picked up on same day as refuse (requires further investigation to confirm that the convenience of same-day service leads to more participation than does the visibility of recyclable set-outs on non-refuse collection days; the convenience to participants of same-day collection may also be out-weighed by inconvenience to collectors for whom difficulty in identifying recyclable set-outs has been found to be a problem when refuse and recyclables are collected on the same day).
- Reliable collection service (minimal labour problems and equipment down-time, clear instructions to householders about status of collection during bad weather).
- Special containers for recyclables storage and set-out by householders.
- For rural areas, collection centres at regularly used facility, e.g. plaza, post office, school; in towns without refuse collection service, depot location at normal disposal site.
- Programs of longer duration.

Other aspects of program design which are suspected to be, or are being investigated as stimulants to participation, are as follows:

- The association of a source separation program with goals other than conservation can broaden program appeal and attract the support of additional segments of the community; thus, use of the social service labour pool can enhance participation (see section 5).
- Mandatory separation by-laws are conducive to participation under the right circumstances (see section 13), but do not, alone, ensure high participation.
- Past newspaper-only collection programs have had higher participation than multi-material programs, but most recent research claims that three-level separation does not inhibit participation.
- The effect of financial penalties on waste generation is being tested for its effect on stimulating source separate participation and recovery (see Appendix 5).

Attitudinal surveys indicate that perceived inconvenience (lack of storage space, time for material preparation)

is a main barrier to participation. Complaints about confusing collection schedules and infrequent collection have been voiced about programs in which non-weekly pickups are provided and in which various recyclable fractions are collected on different days in the multiple pass system. The perception of not having enough recyclable waste to justify the source separation effort has been identified as another barrier to participation. Surveys indicate that unreliable collection undermines even the most vigorous promotional efforts.

The remainder of the section deals with promotional strategies employed in source separation programs.

Findings include the following:

- Initial and ongoing publicity is vital for sustaining and increasing participation levels.
- Person-hour and materials expenses for publicity campaigns differ widely depending on mode of staffing and cost allocation procedures.
- Initial publicity is easiest to carry out in spring and fall seasons and is less likely to be counteracted by weather-related collection problems that occur in winter.
- Publicity precedes startup dates by as much as six months to a minimum of one week.
- A checklist of publicity tactics would include: slogan/logo, newspaper, TV, radio, community letter, door-to-door canvass, leaflet, and posters. Displays, stickers for set-out containers, calendars, and provision of special containers, are costly but thought to be effective. Approaches to businesses, schools, and community groups are considered valuable public relations activities.
- Newspaper articles and direct letters have been the most successful publicity measures, with posters and school efforts ranking most poorly.
- Of significance is the documented need for continual reminders about source separation since publicity blitzes have only short-term effects.

In Ontario source separation programs, sponsors should be encouraged to employ simple survey techniques to determine appropriate motivational pitches for use in startup promotion. Survey or other feedback mechanisms, and set-out monitoring, can be used after program startup to pinpoint problems with programs. A model questionnaire, an at-curb monitoring format, and a checklist of publicity strategies, should be available for people seeking information from government. Sample logos, slogans, themes, and draft community letters would be valuable aids to program planners.

In Ontario, it would be ideal to test within the same pilot area, but among different test groups, the effect (on recovery, participation, and diverted disposal) of 1) collection frequency, and 2) same-day vs. different-day

collection of refuse and recyclables. Such results would help in designing programs with optimal convenience and cost.

Throughout this section, reference is made to the paucity of hard data on participation except in certain heavily subsidized U.S. pilot programs. In order to acquire these data, government should encourage source separation program operators to monitor participation behaviour, in addition to keeping records on recovery. As gathering meaningful set-out or drop-off delivery data requires costly, repeated monitoring and often tedious tabulation, government should also consider funding systematic data collection within existing Ontario source separation programs. This data collection requirement should be built into future implementation and funding programs.

2.2.9 Source Separation Program Economics (Section 13)

In other jurisdictions, economic viability is not considered to be the only yardstick of success for source separation programs. Nevertheless, the paramount concern for most private and public sector decision-makers is the net cost of a source separation program. The main findings in this section include the following:

- An overall cost-benefit evaluation of source separation is beset by such problems as the lack of hard data, wide regional economic and program design differences, various subsidy practices, differences in the applicability of creditable savings, and the employment of cost allocation methods which (if used) distort program costs.
- Two crucial considerations impinge on the cost-effectiveness question. First, is whether and when savings in collection and disposal costs, should be credited to source separation. When savings attributed to source separation are added to revenues from materials sold, the economics of source separation are generally more favourable. Second, is whether source separation should be viewed as a service that is economically attractive as long as per ton costs are comparable to the costs of refuse operations, or whether source separation should be viewed as a business that is economically attractive as long as profits are made or costs are covered. (The mode of sponsorship--public, private, or third sector--is a factor related to this consideration.)
- Two examples of program economic evaluations, drawn from the two best documented programs in the U.S., are detailed in this section. Both allocation methods employed seek to overcome the distortions which occur when conventional full cost and incremental cost approaches are used. (The former inflates the cost of a source separation program, and the latter understates the cost.) The U.S. EPA recommends that both full and actual costs should be outlined for source separation programs in order for cost descriptions to be useful for decision-makers.

- Experiences elsewhere indicate that infusions of capital, e.g. subsidies for program design and equipment costs, are necessary for source separation programs to "take off." In significant source separation programs elsewhere, operating losses are also incurred, but these losses are often ameliorated by the urgency to find alternatives to conventional disposal and optimism about future increases in revenues for recovered materials.

In Ontario, there are also many hidden costs in source separation programs due to employment of donated services, volunteer or surplus labour, reserve equipment, and so forth. These hidden costs should be represented in cost-benefit analyses in order to depict the full costs (as well as the actual, out-of-pocket expenses) of source separation. In section 12, a primitive checklist of cost and savings/revenue items is presented for further economic refinement, and for evaluation in conjunction with other Waste Management Advisory Board accounting and monitoring work (i.e. the Curry-Cooper study). Ontario source separation program operators should be encouraged to employ the refined checklist, and four accounting principles, in their planning and record keeping activities. The accounting principles include listing:

- full costs, as if no goods/services were donated/borrowed; includes imputed opportunity costs;
- incremental costs actually incurred over and above the budget for whatever operations already exist;
- startup costs represented separately, and amortized/capitalized over a fair (three- to five-year) period of time; includes labour and grants from outside agencies;
- credits from revenues, diverted disposal, and increased efficiencies in any existing refuse operations.

In Ontario, policy-makers should give careful consideration to questions related to capital and operating subsidies. These questions include what amount of financial infusion is needed to allow source separation to "take off;" what kinds of subsidies create continued dependency on subsidies; what constraints should be placed on subsidy recipients in terms of operational performance and data gathering/record keeping responsibilities, referred to in this and other report sections as important for evaluating the impacts of source separation. More specifically, cost record keeping should be one condition for any government-funded program.

2.2.10 Source Separation Legislation as a Special Consideration (Section 13)

In the U.S., there are wide differences of opinion about the effectiveness and public acceptance of laws mandating source separation for householders. Early

comparative studies point out that variables other than legal prescriptions are more responsible for program success. Despite pressure for laws from some interest groups, there is municipal hesitancy to legislating mandatory source separation until programs are well underway. In this section, at least three prerequisites to legislating household source separation are identified:

- vigorous program promotion;
- reliable and convenient collection operations; and
- ensured market(s) for recovered materials.

When the above factors are in place, a mandatory by-law could boost participation and recovery, but if these three factors are in place, a by-law may not be necessary. Claims of high participation have been made for several voluntary programs cited in this section.

In Ontario, it would be instructive if two similar communities with source separation programs were to be tested for the effect of a mandatory by-law on participation/recovery. One community could be approached to enact a by-law and another would act as a control.

Other legislation affecting source separation and enacted elsewhere, includes laws related to 1) anti-scavenging, 2) set-out placement at curbside as opposed to back-yard set-out, and 3) responsibilities of local governments to include source separation among disposal practices. The first two should be encouraged as local legal supports for source separation programs. The third could be considered at the provincial government level as part of a comprehensive waste management policy.

2.2.11 Standard Containers for Householders Participating in Source Separation Programs - As a Special Consideration (Section 14)

In source separation programs elsewhere, twine, grocery bags, reused cardboard boxes, and regular refuse cans, are normally used for the curbside set out or the delivery to depots of source separated recyclables. Despite the ready availability and low cost of these containers, some source separation proponents recommend the use of special containers. This section deals with the functions, designs, and merits of special containers for participating householders.

Special container designs vary from simple bags and buckets, to more sophisticated compartmentalized tubs and stacking units. These container designs differ according to purpose: for kitchen storage; for secondary storage in yard, basement, or porch; and for curbside set-out. Other factors which affect design are container cost, kind and number of fractions collected, stipulations of materials buyers, and local weather conditions. Frequency of collection and local recyclables generation are determinants of container capacity.

Special containers not only have merits for the convenience and inducement of householders, but also have advantages for collection crews. Recyclables are easily contrasted from refuse when collections are on the same day, and the irritation of broken bags, bundles, and boxes is averted. With proper container design, recyclables are better protected, litter is minimized, and small-volume pickup stops can be reduced. These advantages to collection crews can be off-set by the requirement to replace the container at curbside, unless an empty container from one stop is substituted at the next stop, or unless the container is durable enough to be thrown from the collection vehicle onto a property.

The most significant contribution of a special container may be its powerful advertizing impact when placed at curbside. Containers, however, are expensive to the sponsor of a source separation program, unless they are sold to householders. Except for the one example of container sale in this research, "free" containers have been provided by groups who have been given grants to do so, or by municipalities which are operating limited test programs.

As implied by previous Ontario research, and as recommended by many ecology groups in the spirit of "make do," most source separation programs do not perceive special containers to be a priority.

In future Ontario programs, experimental and control groups within test areas could be used to determine whether special containers are related to increased participation when all other system design variables, especially householder preparation requirements, publicity, and collection frequency, are held constant. How containers impact on other system design aspects (cost, optimum collection frequency, labour productivity, collection time, contamination, publicity requirements, and so forth) could also be determined by repeating the test in a number of different programs.

Regarding other initiatives in Ontario, the Glass Container Council could be contacted for an evaluation of glass gobblers used in the Borough of Etobicoke curbside glass collection. Results of a container experiment carried out at CFB Borden in early 1979 under federal auspices, should be examined by provincial government authorities. The planned community of Woodruffe presents an opportunity to design a comprehensive waste management system including household storage designs for source separation.

2.3 Summary of the Significance of Individual Source Separation Programs Described in Report Appendices

From jurisdictions outside of Ontario, six actual source separation programs have been chosen to illustrate how components, discussed in the body of the report, are combined into actual systems. None of these program examples is a model to be emulated in Ontario, but each of these programs has significant aspects which merit consideration for Ontario.

2.3.1 Helena, Montana: A Municipal Newspaper Collection Program Employing Rack-Fitted Packers (Appendix 1)

The Helena program is significant for several reasons:

- The feasibility study, done by a citizen task force in conjunction with public officials, is an excellent example of the approach that should be taken by a community in planning a source separation program. Modeled on earlier west coast engineering studies, the resulting report illustrates the weighing of alternative collection methods, haul options, and market choices. The feasibility stage led to the development of a system ideally suited to local conditions.
- The Helena-type collection method, with rack-fitted packers, has low startup equipment costs, requires little alteration of householder garbage set-out behaviour, does not require heavy recovery in order to operate economically, and is compatible with existing refuse operation equipment and crews. This rack collection method would have wide applicability for communities with local markets for paper, and without markets for glass and cans or without glass/can markets within affordable haul distances. In such areas, single-material newspaper collection programs could make economic sense and have conservation education impact, even though multi-material programs would normally be considered more comprehensive.
- Elected politicians in Helena voted, in April, 1979, to continue the program under adverse market conditions. 1979 contract prices plummeted to one third of 1978 prices, and the first-year federal labour subsidy has been withdrawn. This financial crunch has stimulated a greater cost-consciousness in Helena. Officials now intend to log vehicle and crew performance and to start isolating buried costs. This climate of combined political endorsement and cost-mindedness, appears to be an ideal municipal stance.

2.3.2. Kelowna, British Columbia: A Non-Profit Company Multi-Material Program Including Curbside Collection, Drop-off Centre, and Processing Facility (Appendix 2)

The Kelowna Recycling Society operation is considered by some federal (Department of Energy, Mines, and Resources Canada) officials to be one of two significant

source separation programs in Canada. (The other is in Ontario and is operated in East York, a Borough of Metropolitan Toronto.) While the KRS operation is beset by management problems and inefficiencies, it has the following significant aspects:

- A diverted disposal credit is granted by the host municipality.
- The program is linked to a wider network of source separation programs (the Recycling Council of British Columbia with seventeen member groups), and materials are marketed through this network.
- Materials are hauled to market jointly with materials from a program in a neighbouring community.
- Commercial, institutional, and industrial sources of recyclables are tapped in addition to residential sources. This factor is one mark of a comprehensive program.
- Operations have been expanded from drop-off only, into residential curbside collection.
- Extensive local public education is carried out.
- A working relationship with local civic authorities has been developed over time, and closer integration with municipal refuse operations is under consideration.
- Both fibres and glass are handled, making the program multi-material, another mark of a comprehensive program.
- Special set-out containers have been provided in the curbside pilot area.
- A relatively large equipment pool has been amassed and operations have been mechanized to a level which indicates success in applying bulk material handling techniques to source separation.

2.3.3 Marblehead Massachusetts: A Municipal Multi-Material Program Featuring Compartmentalized Vehicles (Appendix 3)

The Marblehead program is considered to be the most significant source separation program in the U.S. (although some, more recently implemented programs on the U.S. west coast are emerging as significant). The success of the Marblehead program, in which a 25% diverted disposal rate is achieved, is attributed to several key factors as follows:

- An intermediate processor upgrades and markets recovered materials. This intermediary's operation eliminates the need for in-program processing and greatly reduces householder preparation effort.
- A compartmentalized vehicle, for which a capital subsidy was made available by the federal government, is employed in the simultaneous collection of several recyclable materials. Collection is characterized by certain inefficiencies (e.g. short crew days, crew over-staffing), and the vehicle is plagued by certain "bugs," but the compartmentalized vehicle is found to be more efficient than collection of each material in repeated collection passes.

- The community is marked by high socioeconomic status which is thought to be the cause, along with program duration, of high participation.
- The absence of local disposal options, and the high cost of regional refuse disposal, combine to make the program economically attractive. In the cost allocation approach employed in Marblehead, heavy refuse disposal costs are credited to source separation when tonnages are diverted. (The cost allocation method itself is significant since it evaluates source separation in relation to overall waste management costs.)

The Marblehead test program has made two notable contributions to the state of the art by providing for the design, testing, and evaluation of an efficient collection vehicle; and by financing excellent documentation of program operation and economics.

2.3.4 Nottingham, New Hampshire: A Rural Town Multi-Material Program Combining Materials Recovery and Refuse Incineration

The Nottingham prototype is the most comprehensive source separation program in North America. Multi-material recovery from all local sources is integrated with disposal of the refuse residual. This program has been designed to meet the needs of a small rural area which has no conventional disposal alternative. The significant features of the Nottingham program are as follows:

- In addition to the recovery of recyclable newspaper, glass, and cans, the refuse residual is burned in a pyrolytic incinerator; also, a reuse component exists by way of a shed designated for the exchange of reusable items.

- Source separation is mandatory for both residents and commercial waste haulers who deliver to the site. The main motivation of the mandatory ordinance is to increase the technical and economic efficiency of the incinerator. A second motivation is to provide psychological reinforcement for patrons. (Sponsors of the program feel that people are more likely to participate if they know that their individual actions are matched by a majority of the populace).
- Processing activities, although beset by underutilization of some equipment, are matched to local circumstances. These local circumstances include the availability of surplus labour due to state laws which specify two staff persons during equipment operating periods; employment of a town truck to deliver materials to distant markets; low throughput due to low availability of materials, and therefore the need for longer storage between hauls; and the desire to achieve maximum revenue for high quality material. Processing therefore includes hand baling of newspaper, mechanical crushing of colour separated glass in a small glass crusher, and mechanical separation of ferrous from the more valuable aluminum cans, followed by mechanical can flattening.

More significant than the features of the Nottingham program is the fact that over twenty other communities in New England have advanced the state of the art by adapting the prototype to local and regional circumstances. Among the second generation programs, the tendency is toward regional facilities shared by several towns, and toward minimal in-program processing activities due to the employment of intermediaries for material transport and processing. The advantages of these new designs include: better utilization of equipment and labour due to avoidance of excess capacity and duplication at small local plants; economies of scale in processing larger throughputs; employment of more efficient bulk-loading container systems; and improved marketability of materials through centralized marketing.

2.3.5 Seattle, Washington: A Municipally Sponsored, Business Operated Multi-Material Program Testing Financial Disincentives for Waste Generation (Appendix 5)

The significance of the Seattle pilot programs lies in the intent to assess the effect of combining source separation with monetary disincentives for refuse generation. At the six-month stage, data for test areas indicate the following tendency: The combination of source separate curbside service plus refuse disincentive results in slightly higher at-source participation and recovery, than is found in source separate collection areas without the waste disincentive; however, the waste disincentive alone has more impact on reducing refuse tonnages than either the combination of source separate collection service plus waste disincentive, or source separate collection service alone.

Other significant aspects of the SORT program include the following:

- The program is geared to testing the economics of curbside collection. The commitment to gathering hard cost data through rigorous monitoring, and the employment of computerized data analysis techniques, are significant, even though, as a pilot program, economies of scale are lacking.
- Higher market prices are achieved by the pooling of materials collected at curbside with materials collected through the collection contractor's drop-off centre operations. (The contractor operates "buy back" centres in the area.)
- A task basis for paying collection workers has been found to aid collection productivity.
- Same-day curbside collection of refuse and recyclables has been found to be less efficient than collection of refuse and recyclables on different days. (The same recommendation has been made by consultants retained to evaluate the Marblehead program.)
- Special storage set-out bags have been provided to householders.

- The curbside collection vehicle, a modified flatbed truck (which contains bins and can haul a trailer for extra capacity), has been designed with a view to mechanical off-loading in line with post-collection warehousing requirements.

2.3.6 Winnipeg, Manitoba: A Social Agency Newspaper Collection Program Emphasizing Skill-Building and Local Manufacturing (Appendix 6)

Despite its single-material focus and lack of waste management orientation, the WeatherCheck program has several significant aspects:

- The collection stage is vertically integrated with the final manufacture of cellulosic insulation. This total system represents an ideal from the points of view of local economic development through waste recovery and avoidance of dependency on external buyers of recovered materials. Nevertheless, the collection program itself could be jeopardized if alternative "end" products are not manufactured by the company in the event that demand for insulation falls.
- The composition of the labour force connects source separation with other social goals such as skill development for Native people (however, the relatively low wages paid may be considered exploitative).
- The intensive door-to-door personal canvassing of householders marks a substantial promotional effort, and, combined with the social goal of the program, may account for claimed high public participation.
- A business-like management approach is taken, along with apparently professional financial planning.

SECTION 3

PRELIMINARY CONSIDERATIONS3.1 Introduction

Residential source separation may be defined as the segregation of recyclable materials from refuse in the household and the collection or delivery of these materials for eventual reprocessing. This definition could be expanded by including reusable materials which would be collected/delivered for eventual reuse. Two main advantages are associated with this waste management option. Source separation results in materials and energy conservation. It leads to community involvement and education in waste management. A third advantage is that, in certain circumstances, source separation may be accompanied by a reduction in refuse collection and disposal costs.

Source separation programs began to appear at the birth of the North American ecology movement in the late 1960's. There are hundreds of programs in operation now. While source separation is associated with curbside collections and drop-off centres, there are many variations in system design, as will be seen in this report. Among the activities necessary for program implementation, three are key: obtaining markets for collected materials, developing an efficient materials handling system and achieving public participation.

Many examples of significant programs and innovative practices hail from the United States. Some national differences are sufficient to render U.S. experiences inapplicable to the situation in Ontario. The different economic, political and social climate in the U.S. may be more conducive to source separation. It will be helpful then, to pinpoint national differences both as a caution to borrowing U.S. data, and as an illustration of favourable conditions for source separation. The following points are not statistically founded, but are believed to be valid conjectures.

3.2 Factors Conducive to Source Separation in the U.S.A. Legislation:

The U.S. federal Resource Conservation and Recovery Act (RCRA) of 1976, among its other provisions, proscribes unsound disposal and prescribes funding for the research and implementation of waste management alternatives. The Act encourages source separation and one of its first applications was to make residential source separation mandatory at federal military installations with more than 500 households. Various state and regional governments have also set deadlines for unsound disposal site

closures and have designated funds for public planning for alternatives. Refuse disposal is considered a national crisis, making resource recovery a public priority in the U.S. Except for a few officials in heavily metropolitanized areas in Ontario, this public urgency does not exist. This is because cleanups of open dumps have been carried out already and/or because open space is plentiful. The scenario of a small town faced with absolute loss of disposal options does not exist in Ontario. In the U.S. the new expense of sound disposal makes source separation more financially attractive.

Another legislative boost to source separation comes from the U.S. Comprehensive Employment Training Act. This job-creation subsidy program funds workers in many U.S. source separation programs because skill spin-offs in truck driving and machine operation are possible for CETA workers. Evidence of this kind of funding exists to a lesser extent in Canada.

B. Resource Inventories:

The U.S. public has been directly touched by fossil fuel shortages since the winter of 1974, making energy conservation a convincing need. Resource inventories which show low U.S. domestic reserves in virgin materials, especially favour the reclamation of paper. The U.S. economy does not have the same stake in pulp extraction as does Canada, although pulp shortages have been forecast here for the 1990's. Not only perceived resource shortages but also a patriotic spirit of national self-sufficiency contributes to the fact that according to the U.S. Environmental Protection Agency almost every U.S. town has some form of source separation program. (1)

C. Waste Composition and Collectable Fractions:

In the U.S. the predominance of one-way beer and pop containers in all but a few states, contributes to the recoverable tonnages of lightweight but high revenue aluminum cans. Such containers are non-existent in Ontario under legislation aimed at source reduction. The presence of aluminum in the recyclable can category affects the applicability to Ontario of U.S. collection vehicle designs, processing activities and revenue data. In the U.S., the northwest enjoys a market for plastic, motor oil is being collected for re-refining, and markets for mixed (grades of) paper are more available.

- D. Corporate Involvement in Creating Demand:
The existence of a newspaper de-inking industry guarantees the marketability of source separated newspaper in several U.S. regions. No such industrial counterpart exists in Canada. In contrast, U.S. glass manufacturers have not been as eager to buy post-consumer waste glass as have Ontario manufacturers. Aluminum can companies are vigorous proponents of source separation in opposing "bottle bill" legislation in the U.S., and because of energy savings, they support the manufacture of products from reclaimed materials.
- E. Intermediate Processing:
Most multi-material source separation programs are found on the extreme U.S. west and east coasts. This is partly due to the location of markets for cans and glass and the availability of intermediate processors who upgrade low quality source separated recyclables. These intermediate processing companies were spawned by the joint public demand for reclamation and the reluctance of industry to accept contaminated materials. The significance of medium-technology processing is that little preparation effort is required of participating householders, or of program sponsors, in a trade-off for lower materials revenues. Multi-material intermediate processing is non-existent in Ontario. The only departure from traditional metal scrap and paperstock dealer activity, is the planned glass beneficiation plant in southern Ontario. This plant will upgrade the quality of post-consumer waste glass and produce kiln-ready glass particles.
- F. Source Separation Advocacy:
Public interest group activity is more vigorous in the U.S. than in Canada. At least four national groups have adopted waste management as a central issue, partly as a result of federal funding for such crusades. Local groups abound and directly sponsor source separation programs. Coalitions of ecology groups and other parties involved with source separation are found in the extreme east and west. In Ontario's 800 municipalities, there are only several dozen community groups which operate source separation programs. There are no province-wide public interest groups with active source separation promotion activities. A Recycling Council of Ontario is currently emerging however, to fill this gap. Organized by a Toronto group, it is modeled on the Recycling Council of British Columbia.
- G. Entrepreneurial Activity:
Commercial hauler involvement in source separation is on the increase in the U.S. This is in response to a number of factors: pressures from municipalities who award haulage contracts; legislation against unsound disposal sites; availability of demonstration

grants from government and industrial associations; better marketability of materials and the public relations value of recycling. There is also an evolution among U.S. ecology groups into non-profit recyclables hauling and consulting companies. This trend marks the end of the education-only aspect of source separation programs, and the beginning of a second generation of program sponsors that are increasingly cost-conscious, business-like and serious about diverting/conserving significant amounts of recyclable material. As this new non-profit business sector grows, conflicts arise with competing traditional haulers. The opportunity seized by intermediate processors is another example of U.S. entrepreneurial vigour.

3.3 The Debate about the Compatibility of Three Waste Management Options

Before looking at data about source separation programs it is instructive to review the current climate of discussion in the U.S. about the compatibility of three waste management options. These are source reduction, source separation and resource recovery. Reduction includes legislative and educational strategies geared to diminishing the amount of waste generated by the producing industries and the consuming public. Examples are container bans or mandatory deposits, tax disincentives for over-packaging, product design regulations and promotion of selective buying habits. Resource recovery is the mechanical separation of mixed wastes, diverting inorganic fractions to recycling. Organic fractions may be diverted to energy recovery.

At first glance these options seem compatible and indeed, much attention has been given to the need for all three in a total package for waste management. But the battle lines being drawn in the U.S. and the economic realities of the options have implications for source separation, the topic of this report.

A. Conflicting Views:

Waste reduction and source separation are supported by public interest groups who value low-technology, long range solutions to waste management, and decentralized, self-reliant community structures.(2) These educators are joined by groups actually operating source separation programs and to a lesser extent by businesses and municipalities (such as Seattle, Denver, Washington, D.C., and Portland) undertaking source separation programs. The very few intermediate processors who depend on a certain throughput of metal and glass containers do not advocate source reduction(3) but all of the above applaud the flexibility and low capital risk of source separation in responding to market mechanisms. These advocates are joined by the de-inking industry which has the most to lose if papers are burned for energy instead of recycled for fibre value. High-technology is viewed as high risk, polluting and

socially destructive and is attacked for its zero impact on reduction. If mixed wastes are carted away to a mechanical recovery plant, the public will think that waste is not a problem. It is also feared that once a community commits heavy capital to such a plant, other options are foreclosed as the plant must be fed enough refuse to make its operation cost-effective.

Resource recovery is supported, on the other hand, by municipalities faced with the need for immediate alleviation of mounting wastes when illegal disposal operations must be halted. Large waste management conglomerates and sponsoring industries are joined in their support for these plants by utilities who see Refuse Derived Fuel (RDF) as a substitute for dwindling or high priced fossil fuels. If these mechanical recovery proponents are to invest capital in plants, they require guaranteed amounts of refuse, both marketable inorganics and combustible organics, in order to finance the fixed costs of operation.

B. Fiscal Realities:

Taking a closer look at economic realities, source separation has the advantage of low capital costs but is making a small dent in waste quantities. In two early engineering studies, drop-off centres were found to be capturing little more than 2.5%(4) of residential waste in localities with programs while curbside collection programs were diverting an average of 4.8% of residential waste.(5) A 25% diversion level has been reached in the most successful U.S. test area.(6) To the municipal engineer faced with a capacity-filled landfill, these contributions are less than adequate. Resource recovery plants offer the highest potential for short-term solutions because they can process massive quantities of urban wastes. Yet existing mechanical recovery plants are fraught with technical operating problems in addition to high capital costs.

If mechanical recovery can be "de-bugged" and modified for local circumstances, the question for decision-makers will become one of whether the high-technology option can be flexible enough to operate with a fluctuating waste stream. The waste stream may change due to "normal" shifts in the economy such as the increasing use of plastic packaging and increased recycling of newsprint. There may also be engineered changes in the economy resulting from fiscal and regulatory measures related to disposal.

Right now in the U.S., measures are being taken to prevent fluctuation in the waste stream. Adopting "flow ordinances", several cities served by mechanical recovery plants have signed promissory agreements to deliver guaranteed amounts of waste

to plants. Penalty fees are paid when minimum quantities are not delivered. There are also provisions that forbid access to plants for haulers who resell portions of their waste to secondary materials markets, which amounts to a proscription of source separation.(7) Here is the dilemma. Without shared cost responsibilities, the financial losses due to free market and/or legislated changes in the waste stream, would be unfairly borne by plant owners; but these flow ordinances also prevent the implementation of cheaper, job-creating, long-range waste management solutions.

In order to assess the consequences of mixing waste management options, a study was done by a top official in the U.S. EPA. The study examines the impact of source separation and waste reduction on the economics of mixed waste recovery plants. The author assumes that 35% of residential and commercial waste is fibre. This is a national U.S. average, adjusted for fibre already recovered from the waste stream. He then shows how a hypothetical RDF plant is affected by a municipal source separation program that recovers 10%-20% of the waste paper generated. Depending on whether the plant has a fixed or expandable service area, the increased disposal charge to cover fixed plant processing costs, would have to be \$.71-\$1.35 per ton. For metal and glass fractions affected by "bottle bill" legislation, very tentative calculations depend on whether beverage containers alone are diverted from the plant or whether the absence of beverage containers renders the rest of the metal and glass front-end recycling economically unfeasible. With container legislation the net revenue loss to the plant would range from \$.35-\$1.15 per ton of waste.(8)

3.4 Summary and Conclusions

A number of economic, political and social conditions favour source separation in the U.S. more so than in Canada. These include: a national disposal crisis with a high public profile; legislation promoting waste management alternatives; government demonstration grants and job-training programs; resource shortages; high-revenue aluminum can relamination; newspaper de-inking plants; a growing multi-material intermediate processing industry; social organization advocacy of source separation; entrepreneurial vigour of commercial haulers and non-profit companies.

The debate about the compatibility of waste management options rages in the U.S.(9) This debate is in infancy in Ontario and may be able to be avoided with proper planning. Resource recovery while yet to be technologically perfected, has the capacity to realistically handle large amounts of waste, despite its capital cost and associated option-cutting effect on source reduction and separation. Source separation carries long-range

job-creation and waste reduction potentials, is cheaper, and is more flexible in a changing waste stream. The challenge to policy makers is to combine these approaches and design cost sharing responsibilities so that:

1) source separation and reduction options are not foreclosed, and so that 2) mechanical recovery plants are not rendered unfeasible when waste is diverted and/or reduced.

SECTION 4

INTRODUCTION TO
SOURCE SEPARATION SYSTEM DESIGN COMPONENTS EXAMINED

4.1 Interlocking Components in Various System Designs

Residential source separation is the act of segregating recyclable/reusable waste material from refuse by the householder. Source separation can occur only where systems are in place for the movement of segregated materials from households to secondary material user industries. Such systems are called source separation programs or at-source recovery programs.

A source separation program is a set of activities undertaken to procure, collect, and market separated material. Since there is no one uniform set of activities which is appropriate for all local circumstances, source separation programs include a variety of system designs. For example, a program operating design may be as simple as separate collection of newspaper by spare municipal trucks which haul paper directly to local market. Another program may be more complex with the collection of several materials through both pickup by special compartmentalized vehicles and delivery by individual householders to drop-off points; this collection may be followed by processing and storage of materials at a central program site before materials are hauled to distant buyers.

Despite the variety of system designs found, all source separation program activities revolve around the three key system requirements of material procurement, collection, and marketing.

Marketing is of paramount importance, since a buyer, preferably within affordable hauling distance, must be found before program design can continue. Marketing activities include obtaining estimates of waste generation and composition so that the amount of available/recoverable materials can be discussed with potential buyers. The availability, distance, and specifications of buyers determine the number and kinds of fractions to be collected (and therefore the design of collection vehicles or drop-off points), and the degree of material quality to be achieved. Material quality requirements, and to some extent market distance, will necessitate decisions about where and how, in the material flow, materials are to be upgraded and reduced in bulk. Such processing activities may occur in the household, and/or at a central site, and/or at an intermediary's site. Marketing also includes designing a method by which collected materials are transported to market. Marketing considerations affect all other aspects of design.

Collection from households can be accomplished by pickup or drop-off, or both in combination. In the latter mode, different kinds of drop-off points can be established, e.g. unmanned bins, manned collection centres, mobile sites. Such points can be established in single or multiple forms. Pickup can be accomplished in different kinds of vehicles ranging from unmodified, spare refuse collection trucks to specially designed compartmentalized vehicles for the concurrent collection of several kinds of materials. Opting for the pickup mode necessitates decisions about vehicle design (function and capacity) in conjunction with frequency of collection, integration of source separate collection with refuse collection, and concurrent or non-concurrent collection of several source separated materials.

If collected materials are not transported directly to local markets in pickup vehicles or vehicles which service simple drop-off points, then a handling facility must be established for the off-loading of collected materials. Such sites must be compatible with the design of incoming and outgoing vehicles. Other activities performed at such sites are ultimately determined by the availability, distance, and specifications of markets, although program priorities, not directly related to marketing, may determine handling facility activities, e.g. waste disposal, vehicle servicing, and so forth.

In more complex program designs, the system requirement of collection must be expanded to include handling (storage and processing) activities beyond the collection stage. These collection, handling and transport activities form the basis for an operating system whose design is linked to both material quality specifications (the result of marketing) and quantities recovered (the result of procurement).

Procurement covers the activities undertaken to recruit participants who supply the source separated materials to be collected and marketed. Procurement is partly a matter of conducting an initial and ongoing public education campaign that is suitable for a given community. Procurement is also a matter of designing a collection system that is convenient, reliable, and visible. Some significant source separation programs are also trying to effect participation by introducing financial incentives, relaxed householder preparation requirements, specially provided containers, and mandatory bylaws.

Underlying the three key system requirements of procurement, collection, and marketing, are parallel structural and measurement activities.

A program must have a sponsoring body which will carry out feasibility research, marshal funds, design the program, and oversee ongoing operation. Sponsorship may come from the public, private, or third (non-profit

company, volunteer group, social agency) sector, or from a combination of these sectors cooperating with each other. The sectors vary in their motives for establishing source separation programs and in the resources to be made available to programs.

Calculation of system cost-revenue is a key activity in arriving at some of the marketing/collection-related decisions referred to above. Other data gathering and record keeping are essential to program evaluation and streamlining.

To summarize the foregoing discussion and to introduce the sections that follow, there are three key interlocking system requirements in a significant source separation program: 1) the carrying out of effective marketing activities; 2) the design of efficient operating systems; and 3) the achievement of optimal participation and recovery. In addition, such a program would be competently administered and staffed, and be committed to data gathering.

In line with the foregoing list, the body of the report starts in section 5 with structures, since a source separation program begins with organizations and individuals who sponsor, administer, and operate programs. The next section, section 6, treats marketing, the first and foremost system requirement. Sections 7-10 focus on operating requirements and operating systems that have been/are being designed for low and high density population situations. Section 11 treats participation which is the third system requirement and a topic which involves data gathering. Section 12 concentrates on economic data. Sections 13 and 14 deal with the two extra topics of legislation and special containers. These latter two topics are related to participation but deserve separate treatment after the main topics in the body of the report are covered.

4.2 Specific System Designs

Sections 5-14 of the report deal with individual components of source separation programs. Each component is assessed for its significance to the state of the art and its applicability to Ontario. But except for the presence of certain short program examples, the body of the report does not show how the various components would interact in an actual program; consequently, six actual source separation programs have been chosen to illustrate how the various components--structures, marketing, operating systems, participation, and economics--fit together in practice. None of these program examples should be considered as a model for emulation by Ontario, yet each of these programs has significant aspects which merit further consideration.

SECTION 5

SPONSORSHIP, ADMINISTRATION AND LABOUR
IN SOURCE SEPARATION PROGRAMS

5.1 Introduction

This section focuses on the social structural side of source separation technology - who is doing what in implementing source separation programs. A discussion of the human resources involved in source separation, is important for several reasons.

Although source separation has its roots in the volunteer sector (the ecology movement of the 1960's), the public (government) and private (business) sectors have become increasingly involved in source separation. The action and interaction among the three sectors in other jurisdictions, should be noted by decision-makers in Ontario.

Among the three sectors, there are differences in motivation for involvement in source separation. The motives include goals as disparate as conservation, dollars, public relations, waste diversion and skill-training. There are also differences in available resources (funds, expertise, equipment, manpower) among the sectors. These differences in resources are reflected in further technical sections of this report. Taken together, these differences in motivation and resources, have consequences for the present "image" of source separation, as well as its future as a waste management alternative.

The following discussion will first outline the roles played by the three sectors in source separation program initiation and administration. Secondly, innovative trends are highlighted. The "who" of source separation would not be complete without a discussion of the "front line" workers who actually handle the materials. References to these "front line" workers permeate the entire section. A detailed discussion of the labour force is provided at the end when engineering studies on labour are summarized.

5.2 The Three Sectors and Their Roles5.2.1 The Public Sector - Government

A. National and state officials and their region-based counterparts, administer federal and state laws related to disposal, reclamation and job-creation. They lend technical and financial support to lower government levels, and to various other categories listed below in the private and volunteer sectors.

B. County, municipal and town officials supervise local disposal activities. (Confronted with loss of conventional disposal options under legislation from upper levels of government, they tend to favour RDF and mechanical recovery, as means of diverting significant amounts of waste from disposal.) They are the beneficiaries of federal and state waste management and job-creation funding programs. Their source separation programs are usually funded by cost-sharing arrangements among various levels of government. They contract for the services of consulting companies and commercial haulers. They also contract to sell municipally collected materials to dealers and secondary materials users.

Administrators of municipal source separation programs may be part of the existing public works, sanitation, roads or public health administration. Alternatively, co-ordinators are hired for a temporary period during program startup. Categories listed in the volunteer sector and the three categories of materials buyers often take a role in initiating municipal programs and in carrying out public education once programs are implemented.

5.2.2 The Private Sector - Business Enterprise

A. Private garbage haulers, or divisions of national waste management companies, contract with counties, municipalities and even with individual homeowners where they are licensed to operate as refuse collectors. Their interest in source separation programs fluctuates with materials market prices. The trend for municipalities to contract separate collections to this category is gaining momentum.

B. Secondary materials user industries and their associations promote and co-sponsor local reclamation programs. Co-sponsorship with municipalities and volunteer groups may include one or a combination of the following services:

- printed implementation materials
- expert consultation
- provision of, and "free" pickup of, containers at collection centres or central (disposal) facilities where curbside collected materials are off-loaded
- provision of equipment for glass and metal volume reduction
- publicity grants
- contract to purchase materials
- financing of program overhaul or evaluation by consulting companies

This category includes glass container manufacturers and their associations; the aluminum and steel industry; the paper recycling industry; other paper manufacturers and their associations.

C. Consulting companies are retained by federal, county and municipal governments and by secondary materials user industries to design, streamline and evaluate programs. They are seldom hired by volunteer groups. Consulting engineers may have once worked with ecology groups, non-profit reclamation companies, private haulers, secondary materials user industries and government or with a combination of these under umbrella organizations.

D. Non-profit companies are a relatively new addition to the source separation scene and stand somewhere between the volunteer and private sector. They are classed with the latter here because their curbside and collection centre operations resemble businesses. Most of these companies have been spawned by ecology groups in an effort to undertake practical demonstration programs. These companies are vigorous advocates of low-technology source separation programs and differ in their acceptance or rejection of mechanical resource recovery and RDF plants.

In communities where franchise mechanisms are under discussion (The community is divided into workable sections for private garbage haulers who contract directly with householders. Only one hauler would be licensed to operate in a given area as opposed to several competing haulers), non-profit companies fear the loss of prized recycling households. They are increasingly seen as a threat by local haulers because of amounts diverted from disposal.

E. Intermediate processors sort and upgrade several source separated fractions. (This category is discussed in detail in Section 10.) They are opposed to mechanical recovery of mixed refuse, to RDF plants and to refillable container legislation--waste management options which could cut into their supply. These processors acquire (usually buy) materials from municipalities, charitable groups, non-profit companies and ecology groups, and resell to other dealers and secondary materials users. They are beginning to attract financing by major banks and are seen as valuable for job-creation opportunities. They co-sponsor local reclamation programs in the same manner as do secondary materials users.

F. Secondary materials dealers buy and upgrade single source separated fractions for resale. (The single fraction may include different colours of glass or different grades of paper.) They may co-sponsor collection programs in the same manner as do secondary materials users and intermediate processors. Paperstock dealers may also contract with a municipality to provide a collection system in return for revenue sharing. Besides paperstock dealers, this category includes cullet dealers and the detinning industry.

5.2.3 The Volunteer Sector

A. National public interest groups promote source separation. At least four national U.S. groups have adopted solid waste as a major concern: The League of Women Voters, The National Wildlife Federation, The Environmental Action Foundation and The Institute for Local Self-Reliance. The League of Women Voters and The Environmental Action Foundation are federally funded to produce implementation manuals and other promotional materials for source separation. The National Wildlife Federation is federally funded to hold regional workshops in rural areas in order to animate communities in the search for alternatives to disposal. The Institute for Local Self-Reliance is an advocacy organization, whose main spokesperson has been criticized for exaggerating the advantages and breadth of source separation at the expense of reality. The same criticism has been leveled at west coast ORE Plan proponents whose claims have been called mythical and counter-productive at a time when source separation needs realistic appraisal.

B. Ecology and naturalist groups operate local collection centres and curbside programs. They are resorting to more business-like procedures and some have evolved into non-profit companies.

C. Service clubs and charities such as scouts, Women's groups, church groups and other fund-raising organizations operate depots and hold curbside collection drives. Their motivation differs widely from the ecologists. Some fears have been voiced from this category about franchised private haulers and municipal curbside proposals--fears that their fund-raising efforts would be impeded. At least one article written by a secondary materials user industry claims that not only can municipal and charitable collections coexist without a loss to either but also that tonnages will be higher for each due to heightened publicity.(1) There is often a co-sponsorship of collection programs with dealers and secondary materials users. Alternatively these groups offer publicity services to municipalities if their main program is not solely fund-raising.

D. Umbrella groups are classified with the volunteer sector as they play a networking and lobbying role; however, their membership may combine part or all of the categories mentioned so far--members differing widely in motivation but holding a common concern for reclamation. Both California and Massachusetts have local federations pressing for low-technology source separation.

E. Social service agencies include sheltered workshops for the mentally and physically disabled; youth employment or delinquency prevention programs; probation, parole or prisoner rehabilitation programs; job-creation programs for the unskilled employables among racial minorities. This category is playing a role in providing labour for source separation programs sponsored by the public and private sector and other volunteer sector categories. Alternatively, these agencies run autonomous source separation programs with the double goal of skill acquisition and resource conservation. Indications are that the addition of the rehabilitative goal has a high public relations value, resulting in heightened public participation in reclamation efforts. (The same may also be true of the service club/charity category where the motivation is primarily profit.)

Comment: The volunteer sector, especially subcategories A, B and D, plays an important advocacy role for source separation. The pressure of ecology, public interest and umbrella groups may sustain public or private source separation programs operating at a loss or costing more per ton than refuse management. Both municipalities and private haulers recognize the public relations value in running source separation programs that are unprofitable from a strict dollar point of view.(2) The acceptance of post-consumer waste (as opposed to in-plant waste) by large secondary materials users is not only a response to energy, pollution and financial savings, but also a response to public relations value in recycling.

5.3 Innovative Trends among Sectors

5.3.1 Municipal Use of Private Haulers

Municipalities are turning to the private hauling sector for source separate collection. Using private haulers is thought to be more economical (than expanding municipal operations) for source separate collection when municipal crews and equipment are already used to capacity for refuse collection. The private sector is seen to be more diligent with respect to expenditures, streamlining and marketing in order to maximize profits or at least break even.

There are two main types of contracts between municipalities and private haulers. A contract with a municipality may stipulate that the hauler collect materials in return for the revenues. The city incurs no out-of-pocket costs and achieves a reduction in the amount of waste for collection and disposal. Alternatively, a hauler or paperstock dealer may contract to provide separate collection services and pay the municipality a set or guaranteed fee per ton of collected materials. As in Fullerton, California, the city would be paid part of the revenue and still enjoy a reduction in waste quantities.(3) The attractiveness of both options, especially the latter, is a function of market price. Only one example was found where a garbage collection and disposal contract stipulates a source separate collection. (Such a specification would not seem unreasonable where markets are favourable.) In Mankato, Minnesota private haulers must adapt their service to a household separation program.(4)

5.3.2 Co-operation among Sectors

As communities in the U.S. are under increasing pressure to close illegal dumps, this crisis situation has led to new trends in co-operation among sectors. Brought together in problem-solving committees, it is not unusual for the following division of tasks to evolve:

- Planning: consultants, local, state, and federal officials, national and local public interest groups, non-profit research and design companies, intermediate processors, umbrella groups.
- Collection system: municipal crews or private haulers supplemented by ecology volunteers, job-creation grant workers, social service agencies.
- Processing equipment, storage container provision and hauling: municipal, private hauler, intermediate processor, secondary materials user, local business donor.
- Marketing services: intermediate processors, municipal officials, ultimate users.
- Publicity: local groups, any level or combination of material buyers, municipal officials.
- Administration: four government levels, private haulers, volunteer groups/individuals.
- Evaluation: municipalities, consultants, volunteer groups.

Such a large cast may not be found where finding alternatives to disposal is less pressing. A survey of New England mayors, for instance, found that garbage is a number one concern. (Another survey found that the source separation program ranks above all other local services in popularity in Nottingham, New Hampshire.)

Examples:

Some examples of unique co-operation include the following: (Most examples below and following have been frequently footnoted in other report sections.)

A. In the State of Oregon, the differences between public interest groups/non-profit companies operating reclamation programs and the public sector is almost non-existent in an atmosphere of unanimous commitment to source separation.

B. In California, The California Resource Recovery Association binds private haulers, consultants, municipal officials, civil servants and ecologists under one umbrella initiated by a secondary materials user -- The Garden State Paper Company which makes recycled newsprint.

C. The famous Nottingham recycling/incineration system was designed by a non-profit ecological research group called Recycling and Conservation, Inc. (Kittery, Maine), which worked in close partnership with rural extension services at the University of New Hampshire at Durham. A second-generation Nottingham System proposal, once under consideration for Lincoln County, Maine, was a combined effort of the same R & C, Inc., and local county planners. Introduced to the public in workshops held by the National Wildlife Federation, this proposal was rejected by a local citizen task force, and a new system was designed by a national consulting company, SCS Engineers, Inc., whose eastern office is headed by a former owner of a source separate collection company.

D. The National Wildlife Federation's efforts in Helena, Montana, graduated to a local citizen task force as have their other workshops in the mid-west, northeast and southeast. The task forces conduct feasibility studies and make recommendations to local councils for source separation programs where feasible.

E. Branches of the League of Women Voters work with local municipal officials all over the U.S. in source separation program publicity development under Environmental Protection Agency grants.

F. The massive National Black Veterans Organization program for collection, processing and marketing materials, involves heavy links with local county and municipal officials around Washington, D.C. The program includes the equipment and marketing services of Resource Recovery Systems, Inc., a Connecticut based intermediate processor.

G. Ecocycle of Boulder, Colorado has the goal of developing a model separate collection system that may be duplicated. They are presently conferring with officials of five interested nearby cities about setting up independent corporations in each location.(5)

5.3.3 Use of the Social Service Labour Pool

The use of the social service labour pool in private and volunteer and sometimes public sector source separation programs, not only provides low cost labour but also achieves the three following results:

- Perceived benefits of the reclamation program may increase when source separation is associated with the rehabilitation of social problem target groups.
- As labour is subsidized, the program may break even or generate a profit more readily than if paid labour were the only option. (The luxury of cheap labour may also cause a program to be run less efficiently. Furthermore job-creation grants may create a dependency on subsidized labour, making it unlikely that the program would ever be self-sustaining.)
- The skill training and employment potential of source separation programs helps to overcome public fears that an environmentally-sound economy means fewer jobs.

These benefits also occur when social service agencies spawn their own autonomous source separation operations. Following are some examples of the rehabilitation labour pool:

Examples:

A. The U.S. federal government funds job-creation programs through the Comprehensive Employment Training Act (CETA). Several source separation programs run by private haulers, municipalities and non-profit companies, and examined in this research, have CETA workers on staff.

B. In Arcata, California, a non-profit business called Arcata Community Recycling Centre, runs a town and rural depot system. Paid persons, CETA workers and local volunteers are helped by people sent by the courts to "do time" for parking tickets and other small offences. A notable contribution of a publicity poster design came from an artist who was "sentenced" to A.C.R.C.

C. Residents Recycling, a program run by officials in the Cambridge Housing Authority, employs youths from public housing projects to collect source separated recyclables from tenants.

D. The National Black Veterans Organization has received heavy CETA funding for a national model business venture involving collection, intermediate processing and dealership.

E. In San Luis Obispo, temporary help is periodically needed by the private hauler for loading stored paper into large vehicles for transport to market. Labour is provided by a local prison for the cost of one supervisor's time.

F. Project Arrowhead, a sheltered workshop in Duluth, Minnesota, runs an urban collection and rural satellite depot program staffed by handicapped persons. Administrators know that the program would not be economically viable in its present design without heavy subsidies.

G. The Portland Recycling Team justifies its use of CETA workers by citing the employment spin-offs for truck and processing machine operators. As front-line workers may not themselves be ecologists, PRT administration emphasizes personnel management as well as technical training. Equal emphasis is placed on other social goals (besides the separate collection), such as stabilizing the economy, innovative end uses for fractions and urban renewal in warehouse locations.(6)

H. Ecocycle of Boulder, Colorado, prides itself with the best Saturday collection scheme in the U.S.A. Unable to pay workers, this non-profit company "sub-contracts" to school bands and other youth groups for a flat rate of \$250 per day. The program is publicized with the joint goals of ecological preservation and community development through youth activity.

Comment: When contacted, none of these groups had systematic accounting procedures for the impact of subsidies on labour costs, although they all agree that cost analysis is important. Some think that they could break even or make a profit if these labour subsidies were to be withdrawn.

5.3.4 The Emergence of Non-Profit Businesses

Implicit in some of the above examples (PRT, A.C.R.C., Ecocycle and many others not cited) is the emergence of source separation companies, evolved from ecology groups. These companies are outside the pall of

traditional waste hauling, dealing and brokering. They are motivated more by ecological and educational concerns than by profit. This new sector is experiencing internal and external conflicts.

Crippled by a lack of business expertise in their late sixty's idealism, many groups have acquired business acumen over the decade. Many are concerned about keeping their "conscience" in a competitive business climate and are resisting the tendency to become scrap dealers. Generally the source reduction and reuse philosophy is preserved. These groups tend to be dependent on grants, are expert at marshalling donated help and services, operate with low costs per ton, but are weak in hard cost data analysis. In some localities the non-profit groups are warring with commercial haulers who perceive a threat from reduced disposal quantities as a result of source separation. These new businesses are critical of the commercial sector's source separation efforts, which are vulnerable to market price slumps and tend to be aimed at only profitable fractions.

5.4 The Conventional Labour Force in Public and Private Programs

The labour pool that has not been discussed is the conventional labour force in municipal and private source separation programs. This core work force deserves special consideration because paid labour adds high costs to source separation budgets. While labour productivity measures are rarely calculated for volunteer, social agency and non-profit company labour, there are several available consulting studies which take a harder look at labour requirements and costs for municipal and commercial source separation programs. Several examples follow:

5.4.1 Curbside Collection Studies

A. Quantitative Research:

A 1974 study of twenty-two curbside programs compares two collection systems. In the five rack approaches (four municipal, one private), crew sizes average 2.8 men and are the same (crew-sizes) as before the separate collection systems were implemented. In all case study locations, despite different participation rates, crews are able to absorb the extra time required to load racks at collection stops, transfer paper to bins when racks fill before the body (of the truck), to unload racks at central facilities and to drive the paper to paperstock dealers. Workers used to assist in these extra source separation tasks are from existing labour pools but their wages are not allocated to the source separation programs; consequently, the "fat" in the total refuse system absorbs the extra labour costs required by source separate collection.

In the eleven municipal separate truck approaches, only two cases use part-time hires to supplement crews from existing/reserve labour force. (In multi-material programs, only one fraction is picked up at a time.) No one-man, side-loading vehicles are used and the authors conclude that crew sizes, averaging 2.8 men, are too large for rear-loading packers picking up small amounts of recyclables at curbside. As labour costs are not allocated to source separation, these excessive crew sizes are absorbed by the refuse collection budget. However, paring crew size would have a favourable impact on net savings to the total system (garbage and recyclable collections) as shown in a simulation analysis. In terms of productivity, authors find that separate truck crews collect an average of 5.5 tons of newspaper per day, 1.7 tons of glass/day and 1.1 tons of metal/day.(7)

B. San Diego, California, Case Research:
Characteristic of the systems approach, labour requirements for a source separate collection program cannot be estimated in isolation from such variables as vehicle, frequency of collection, publicity, participation rate and haul distance to central facility. In early 1976, consultants were hired to streamline San Diego's inefficient separate truck collection system which would have to be either improved or discontinued, once the City's grant for CETA workers expired. After examining five options, the authors propose the integrated rack approach as a solution. This approach would allow cost-effective collection and transfer at existing participation rates without the CETA workers.(8)

C. Helena, Montana, Case Research:
Modeling their work on existing consulting methods, a local citizens Task Force made a detailed proposal to their City Council for the rack system of newspaper collection. In their feasibility study, members dismiss a one-man pickup truck approach and a two-man separate truck approach for several reasons in addition to cost. Using a series of simple formulas, the citizens fed in rates for paper generation and participation as well as estimated times for pickup and off-loading operations for each trip to the central facility by available crews. They estimate that the rack option using existing refuse crews, is not only cost-effective but also, taking into consideration wage rates and estimated revenues, profitable.(9)

D. Palos Verdes, California, Case Research:
Another example of the connection between manpower and collection vehicle design was an experiment in Palos Verdes, California. Due to the space constraints of conventional racks, a normal packer was modified for test purposes. A bucket loader was installed to lift newspaper into a special large compartment in the upper front bulkhead of the packer. At first it was

found that the one-man crew could not absorb the incremental time requirements of separate collection. There was the need for manual off-loading at the central facility, and there were irritating waiting periods on the collection route, when the dismounting driver forgot to activate the slow-paced, low-capacity bucket mechanism. But modifications, made or recommended, cut labour route time in half and eliminated manual off-loading. Better transfer facilities, improvements in bucket speed and relocation of loading controls--coupled with driver familiarization, these modifications made the collection system cost-effective.(10)

E. San Luis Obispo, California, Case Research:
In San Luis Obispo, where a container train is used by a private hauler to collect metal, glass and paper, two full-time men are required for collection and handling of an average of sixteen tons per day. Labour requirements are as follows:

- Collection: Route loading responsibilities include quality control for three categories of materials. Calling cards are used to alert householders to violations of separation requirements. The two-man crew finishes the route in six hours, but spends another two hours off-loading, transferring materials to storage and crushing cans. At \$4.00/hour plus benefits at 1978 U.S. rates, this crew costs \$1,872/month.
- Materials handling: Off-loading and transferring materials to storage containers take two to three hours per day and are the responsibility of the collection crew. The crew makes two to three trips per day to a central facility, but at peak periods, when set-out participation is high, additional help is required for handling so that the collection crew can return to the pickup route. This help is provided by administrative workers.
- Administration: The little supervisory assistance required by the company includes responding to complaints about missed collections, helping the collection crew to improve materials quality control and occasional assistance in off-loading and processing materials at peak collection periods. Substantial administrative inputs from other sectors include consulting services and project management (funded by the federal and municipal governments respectively) for the design, publicizing and evaluation of the program.(11)

F. Somerville and Marblehead, Massachusetts, Case Research:

These two U.S. multi-material (paper, glass, metal) collection test programs have been evaluated jointly by consultants retained by the U.S. federal government. Marblehead recovers 24.4% of residential waste and Somerville's recovery rate reached 8.1% before the program collapsed. Consultants' labour evaluations are summarized below.

1) Somerville: Two crews of three men each worked on compartmentalized recycling trucks and one crew of four worked on a flatbed truck. The large crews (driver and two collectors) were chosen because narrow streets and high residential density enabled both sides of streets to be worked simultaneously with little idle time (dead time) for any worker. The flatbed truck's two collectors handed recyclables to a third stacker/sorter standing on the truck because this truck lacked the hydraulic buckets of the special recycling trucks. The flatbed crew was brought into service because the first two recycling truck crews could not handle material overload. In Somerville, initial staff training efforts were undercut by the need for additional personnel, and the constant exchange of staff between recycling and normal refuse operations. Strikes and labour problems made recyclables collection service unreliable and data gathering forms were not filled in by the collectors. Assignment to recycling was voluntary and work days were shorter than the national average. A productivity measure, based on monthly recovered amounts, indicated that .9 ton per hour was collected by each crew of three.

2) Marblehead: Despite the capability of two-man crews to service Marblehead, three-man crews are used on the two compartmentalized recycling trucks. No training was deemed necessary as staff were familiar with the program rationale from a previous separate collection scheme. Assignment to recycling crews is not voluntary and work days are also shorter than the national average. A productivity measure of 1.3 tons per hour per crew of three is available from precise data-gathering by crew members. Under the old system a single packer truck with a three-man crew collected four classes of recyclables once per month, each fraction in a different week. Productivity then was 1.2 tons per hour per crew of three. As the second weekly refuse collection day has been eliminated in Marblehead, collection of recyclables on that day is expected to speed up. This is because collection crews will be able to identify recyclables without checking to see if containers hold trash or recyclables.

Among the recommendations for source separate collection system design, there are four related to manpower in the above study. (These labour recommendations assume single-pass curbside collection of multi-materials by compartmentalized truck.)

- Two-man crews (driver and collector), or even a one-man crew should be used.
- Source separate collection staff should be chosen from volunteers so that rivalry does not develop with normal trash collection staff.
- A slightly longer average work day for recycling crews than for refuse collection workers is appropriate.
- Recycling crews should be able to service 800 homes and collect five tons per crew day.

The crack recycling teams garbed in special uniforms never materialized in these two communities, but productivity measures for two-man crews in Marblehead are viewed as encouraging. (Such measures were obtained when temporary staff shortages necessitated smaller crews.) Efficient recycling crews can enable a municipality to cut back on normal trash crew routes despite the delicacy of labour relations where layoffs are an issue.(12)

5.4.2 Collection Centre Studies

A. Quantitative Research:

An early study of U.S. collection centre labour requirements looks at six citizen, one commercial and six municipal depot systems. Labour falls into four categories with the respective person-hours per ton listed (regardless of whether labour is paid or unpaid):

Table 1: Collection Centre Labour Requirements
Expressed in Person-Hours per Ton of
Recovered Material

Category: Labour Activity	Person-Hours/ Ton Recovered
Patron Assistance: Helping to unload patron vehicles, directing patrons to unloading locations, and answering questions about material preparation requirements.	3.2 (5 centres)
Material Processing: Sorting improperly deposited materials (upgrading) and/or reducing the volume of delivered materials, e.g. glass and can crushing (most centres), paper baling (two centres) and no processing (four centres).	3.6 (9 centres)
Transportation: Gathering materials from a collection centre for transportation to a central location in the case of the five satellite operations and/or to a secondary materials dealer/user.	4.1 (4 centres) & 10.5 (10 centres)
Administration: Supervisory and/or clerical activities	1.5 (11 centres)

Labour Activities: As implied in the right hand column above, there are wide variations in how labour is used. Only one centre uses labour for all four tasks. Among the three satellite operations that have materials picked up by a central body, economies of scale result because fewer labour hours are required for milk-run pickups. Several centres receive material storage bins and transport services from haulers in trade for lower revenues which nearly eliminates labour needs for processing and transport.

Paid Labour: Regarding labour costs (wages and benefits, if paid, for activities in above chart), the three types (citizen, commercial, municipal) of collection centres differ widely. Citizen-run centres use the most unpaid volunteers. They are able to pay for some labour through federal work-study programs and material revenues. At one citizen-run centre, labour and administrative services are donated by city employees. Generally, labour costs per ton recovered are the lowest at these citizen-operated centres. All six municipal centres have (paid) labour costs that exceed revenues or credits from reclamation. Use of reserve labour forces means that costs are borne by city treasuries. Municipal labour is also subsidized by federal job-creation grant programs as is done in the two municipal centres with the highest labour costs per ton. (Paid labour dollars are not outlined here because they bear little resemblance to current wage expectations.)

Paid Labour Related to Materials Handled: Looking at paid labour on the basis of material type, newspapers involve the least labour costs per ton, especially for centres provided with storage containers by haulers (less than \$1/ton) and for centres that bale paper to facilitate handling and to increase revenue (\$6 and \$8/ton). The highest labour costs per ton of paper are incurred by satellite operations which have high internal transport costs (\$10 and \$23/ton). For glass, the lowest labour costs appear at two centres which let glass fall down a chute as a volume reduction technique (less than \$2/ton). The paid labour cost per ton of glass escalates with the following three conditions: no volume reduction (\$5/ton): satellite collection by a central body (\$23 and \$27/ton); independent delivery to market by individual satellites (\$92/ton). For tin cans, three centres avoid volume reduction and consequently have the lowest labour costs (\$4 to \$8/ton). The rest expend time to reduce volume without the compensation of weight (due to the lightness of metal), resulting in labour costs of \$20 to \$70/ton, soaring to \$245/ton in the satellite system with independent hauls to market. Aluminum resembles tin except in two extreme cases that incur labour costs of \$950 and \$1100/ton for transportation. (1974 U.S. dollar figures are shown here for contrast purposes only.)

Labour Productivity: A labour productivity measure is developed for each centre by determining the number of person-hours spent (on activities in above chart) per ton of materials recovered. Citizen run depots average 7.5 person-hours per ton of recovered material. For the commercial operator, labour per ton equals 3.7 hours. Public collection centres have a 9.2 person-hour per ton average. For all centres, labour effort amounts to 8 person-hours per ton of materials reclaimed. On the basis of this small sample the authors conclude that labour is most productive in commercial centres, followed by citizen and public operations respectively. It is interesting to note that if one inordinately labour intensive citizen centre is deleted from the calculation, citizen centre productivity increases to 3.3 hours per ton.(13)

B. Nottingham System, Case Research:

Based on source separation, this system has been designed for a small rural town (Nottingham), and is being modified for and implemented in other similar areas in the north-east U.S. At the Nottingham town "recycling plant", reclamation is combined with incineration of non-recyclable refuse. It is the processing of glass, metal and paper for shipment to market that necessitates heavy labour inputs (coupled with labour safety laws which prescribe solo machine operation). Two paid attendants work two eight-hour days per week, supplemented by another half-day per week worker during busier summer months. Administration and marketing is done by a volunteer. Paid labour in 1976 came to \$5320. U.S., about three-quarters of the net operating costs for the combined reclamation-incineration system before revenue from material sales. Taking revenues into consideration and total tonnages reclaimed, it appears that labour amounted to \$30/ton in 1976 when the net operating cost was \$4221. Two conflicting reports about labour productivity appear in studies about Nottingham. Labour requirements for the processing of recovered materials are either calculated differently, or processing effort has decreased over time for all but glass fractions.

Table 2: Nottingham Centre Labour Requirements Expressed in Person-Hours per Recyclable Ton Processed

Recyclable Category	Person-Hours/Ton Processed	
glass	2.3	2.3
tin cans	4.9	7.0
aluminum	12.3	17.8
newspaper	2.4	4.7
*Average (all materials)	5.5	8.0
Year	1977(14)	1975(15)

*Inflated by aluminum which brings in high revenue, thus off-setting preparation time.

5.5 Summary and Conclusions

In jurisdictions outside of Ontario, the following trends are occurring:

- Private garbage haulers are playing a greater role in source separation. This is partly due to the fact that municipalities are contracting out more waste management tasks to private enterprise, perceived as better able to run efficient operations. The trend is also partly due to the fact that U.S. markets are more secure; therefore source separation is attracting private enterprise.
- The cogency of finding sound alternatives to illegal disposal facilities unites public, private and volunteer sectors in national, regional and local problem-solving activities. There are political and practical advantages in this pooling of expertise.
- Innovative use of the social service labour pool is on the increase. Funding programs for job-creation assign labourers to ongoing source separation programs and fund agencies who themselves operate programs. This labour pool is comprised of delinquent youths, racial minorities, legal offenders, and handicapped persons. Several advantages are associated with the use of the social service job sector:
 - "Free" or low cost labour.
 - Higher public participation when external ecological benefits are broadened to include rehabilitation of problem social groups as additional advantages of source separation.
 - Job-creation spill-over for the individuals "employed" and for countering critics of environmental projects.
 - A broadened funding base for financing source separation.
- Evolving from earlier ecology groups, a new non-profit source separation business sector is emerging. These businesses still wear some of the marks of their infancy (dependency on grants, reduction/reuse philosophy, interest in unprofitable fractions). In some locations, their existence is perceived as a threat by waste haulers, secondary materials dealers and proponents of mechanical recovery.

These trends in the U.S. have consequences for Ontario government policy-makers and funders. At the current stage in the development of source separation in North America, it is not clear whether source separation should be considered a marginal business, a municipal service, an ecology project, a fund-raising tool or a rehabilitative strategy. The number of goals and practitioners associated with source separation could be an advantage -- many different segments of society working to solve waste management problems.

The many goals and practitioners could also prevent source separation from being perceived by the public as a serious waste management option. In order to increase the legitimacy of source separation, government support to operators of source separation programs, should have at least four conditions. Programs should:

- be well managed;
- have a majority of paid staff (at least minimum wage);
- maintain records on data collection;
- carry out or plan to carry out multi-material collections.

These conditions would discourage one-shot, fund-raising charities, poorly managed ecology groups, single-fraction haulers/dealers at high material revenue periods, and exploitative social service labour pools. The remaining recipients of government technical expertise and/or funding, could be municipalities, social agencies with community reclamation programs, non-profit companies and for-profit businesses. Recipients should be committed to institutionalizing source separation locally and to co-operating in a province-wide source separation system.

In addition to the initiators and administrative operators of source separation programs outside of Ontario, this section looks at the "front-line" collection workers in programs. Aside from remarks already made about volunteer and social service labour, several conclusions can be drawn from the small number of available engineering studies which analyze labour used in source separation programs:

- Labour requirements must be determined with regard for other components of program design: number and kinds of fractions; number and kinds of activities (collection, transfer, processing/handling, storage, hauling to market, etc.); type of program (curbside collection or drop-off centre); equipment design (collection vehicles, balers, crushers); availability of reserve/borrowed/volunteer labour and labour subsidies.

- Crews on both conventional rear-loading packer trucks and compartmentalized vehicles performing separate collection can be pared to two or even one person.
- Programs which process materials incur higher labour costs for these additional activities but such costs may be off-set by higher revenues for upgrading materials, or by lower hauling costs resulting from volume reduction.
- In government funded source separation programs, all labour whether paid, volunteer, or borrowed from refuse collection, should be assigned costs. Labour productivity data (person-hours per ton recovered) should also be recorded. These two techniques would be helpful in program comparison and evaluation.
- Aside from labour cost concerns, source separation planners must be sensitive to the resistance of organized labour and individual workers to source separation programs. New and modified collection vehicles, additional collection responsibilities, and public complaints directed at crews in programs, have caused labour disputes which, in turn have resulted in less reliable separate collection and depressed participation. Front-line workers should be consulted, educated and motivated.

SECTION 6

MARKETING6.1 Introduction

The single most important consideration in designing a source separation program is the availability of purchasers for the collected materials. Without markets source separation is impossible. Without sufficient revenues from markets within affordable hauling distances, source separation programs are not, at least financially, justifiable. The preparation requirements set by markets affect all other components of program design. Together with certain savings (discussed in Section 12) attributable to source separation, market revenues determine the economic viability of a program; however, non-monetary environmental and public relations benefits can sustain programs which operate at a loss.

It should be noted that the title of this section is marketing and not markets. The emphasis is on the state of the art in other jurisdictions for finding or making, and keeping markets. No attempt is made to assess the availability of markets for recyclables in Ontario. Such an attempt would be beyond the scope of this report. The examples listed here, especially of innovative practices elsewhere, will suggest some new research and development directions for Ontario.

6.2 The Demand Side6.2.1 Increases in Existing and New Demand

Increased industrial demand for post-consumer waste is crucial to the implementation of supply mechanisms. Demand can be increased by the expansion of existing markets and/or by the creation of new markets or uses.

Existing markets are expanded when secondary materials users increase production outright. Existing markets are also expanded when secondary materials users increase the proportion of post-consumer waste in their product. The glass industry is currently increasing the use of post-consumer waste glass by percentages upwards of 90% per batch in some plants. Even lower proportions of cullet to virgin materials are thought to be associated with dramatic savings in energy, pollution and maintenance.

New markets are created when manufacturers begin to use (substitute) reclaimed waste instead of virgin material in their processes. This substitution applies to industries that have always used in-plant waste in the past but have more recently started using post-consumer waste.

New markets are also created when new products made from post-consumer waste emerge, such as corrugated cardboard desk-top holders for waste paper reclamation schemes in office buildings. Newsprint recycling is the prime example of a new technology which has had a great impact on stimulating greater supply mechanisms in the U.S. As pulp shortages increase, what was once a new market in 1961, is now undergoing rapid expansion.

Newly created markets may use conventional, recyclable fractions (glass containers, metal cans, newspaper) or may bring new wastes into play: materials that were not previously considered recyclable such as dirty glass, plastics and junk mail. New markets are not limited to the consumption of recyclables. A new market may also involve consumption of reusable wastes; for instance, a bottle washing industry which supplies clean containers to food and beverage bottlers, would create a demand for reusable bottles as a collectable fraction.

6.2.2 Influences on Market Demand

Some of the above examples point out the complexity of supply-demand linkages. In this section, "markets" refers to the parties that buy recyclable materials directly from source separation programs. These buyers include various intermediaries which upgrade and re-route materials (paper-stock and scrap dealers), or process one (cullet dealers, de-tinning plants) or more recyclable fractions. Buyers also include industries which reprocess (use) materials into products that are either indistinguishable from, or comparable to, products made from virgin materials, e.g. glass containers, newsprint, building materials and steel. The latter user industries buy directly from source separation programs and buy indirectly from programs through the intermediaries.

A. Derived Demand in the Market Place

Secondary materials users supply other markets which affect demand. For instance, publishers have to be convinced of the value of recycled newsprint, bottlers and food packagers must be assured of the strength and cleanliness of washed containers, and householders and government regulatory agencies must be sold on the effectiveness and fire retardancy of cellulose insulation. Consumer demand is stimulating the production of recycled greeting cards, re-refined motor oil and fashionable second-hand clothing. Thus it can be seen that demand for post-consumer waste is influenced by factors far beyond the control of the first-level purchasers of source separated materials.

B. Supply as a Factor in Demand

Supply can also influence demand. The buyers' decisions to use greater amounts of post-consumer waste are partly determined by the availability of reliable suppliers and guaranteed quantities of recyclables. Markets have been expanded and created by insistent source separation group suppliers marketing their "raw materials". Cooperative marketing on the west coast has been effective in this regard.

C. Other Factors Influencing Demand

There are public relations, environmental and economic factors which influence demand. The glass container industry does not vigorously back curbside source separation programs in the U.S. because it is feared that the inconvenience of segregating glass in the household will cause consumers to buy canned beverages instead. That industry will, however, place bins at a landfill or collection center site, or accept upgraded cullet from intermediate processors. The glass industry is thought to be able to save on maintenance, use less energy, and create less pollution by increased use of cullet. In one eastern state, a glass container plant was exempted from the legal requirement of installing an electrostatic precipitator if cullet use reached certain specifications. The aluminum industry in the U.S. is a strong advocate of separate collection centers, and sponsors many industry drop-off points partly to reduce pressure for refillable container legislation. This industry claims to be recovering a full quarter of the aluminum cans produced, and to be benefiting from a 95% energy saving by recycling rather than using virgin materials. Markets for "tin" cans are currently depressed because of slow-downs in the whole steel industry. Cellulose insulation markets are booming, at least in the short-term, because of skyrocketing fuel prices, but there is increasing concern about the reliability of this market.

6.2.3 Recycled Newsprint

Because newsprint recycling in the U.S. is the single most dramatic example of increased demand, the operation of the Garden State Paper Company warrants attention. The development of technology for making new newsprint from 100% post-consumer waste started in 1950. Experimentation and sales pressure was intensified over the years, amid skepticism from paper manufacturers, publishers, and the investment community. Since 1961, when the first roll of commercial newsprint was made, the capacity of machinery has been improved to a point where the "Papriformer" produces 3000 feet of offset paper per minute. Water-soluble glue and water reuse are other inventive spin-offs from Garden State. The Company owns mills in Pomona, California and Garfield, New Jersey, jointly operates mills in Alsip, Illinois and San Luis Potosi, Mexico, and started construction on a southeast U.S. mill in 1976. (1)

In Massachusetts and California, Garden State Paper Company has helped initiate waste recovery coalitions made up of citizen groups, businesses and municipalities. The purpose of these organizations is to stimulate source separation programs and other supply mechanisms, as well as to jointly oppose RDF plants which could cut waste paper supplies to the five plants which have minimum capacities of 108,000 tons per year. (2) Garden State's National Procurement

Office produces implementation manuals, negotiates long-term contracts with suppliers, and works with source separation program sponsors and paper dealers to solve technical problems and improve publicity techniques. Garden State has retained consultants to streamline problem-plagued collection systems, and hopes to initiate apartment complex collections. Several of the municipal, private, and volunteer groups examined in this report supply the Company with "raw" material as do many other source separation programs.

6.3 Fractions Collected and Used in Jurisdictions Outside of Ontario

6.3.1 Summary of Fractions Collected

For summary purposes the following fractions are collected in source separation programs operating in jurisdictions outside of Ontario:

Fractions Collected in Different Jurisdictions

<u>Glass Bottles/Jars</u>	<u>Paper</u>	<u>Combinations</u>
flint	newsprint	mixed glass/
brown	high grade	metal/paper;
green	corrugated	mixed glass/metal
brown/green	magazines	
colour mixed	junk mail	<u>Miscellaneous</u>
returnable	paperboard boxes	
refillable	egg cartons	motor oil
reusable	kraft bags	car batteries
	confidential records	car tires
<u>Metal</u>		clothing
"tin" cans; aluminum	<u>Plastic</u>	rag
cans, plates, foil;	food containers	furniture
white goods; drums	polyethylene film	compost

6.3.2 Uses for Source Separated Materials

Following is a summary of principal uses for some of the above source separated materials, plus some examples of prices. Rigid revenue reporting will not be done because of incomplete information, wide price fluctuations, and the inapplicability to Ontario of distant market prices.

A. Glass for Cullet:

For recycling, glass prices vary with screen sizing, colour sorting, metallic and ceramic contamination, and with intervening handlers who have processing costs. Regional variations related to distance from glass plants and the acceptability of colour mixed glass mean that some source separation programs are getting as much as \$30/ton, and others as little as zero. These latter programs continue collecting glass for the public relations value.

B. Dirty Glass:

Markets may be expanding with the emergence of such products as: foam glass cellular acoustic and thermal insulation; columnar composite pipe with high compressive strength (apparently more popular than concrete pipe in such places as New York, New Jersey and Maryland where it has been used for over six years); glassphalt; and construction brick. (3)

C. Returnable, Refillable and Reusable Bottles and Jars:

A new fraction for source separation programs in states with mandatory deposit legislation, non-refillable bottles that are returnable, are marketed to industry or return depots. Refillable bottles are taken directly to beverage bottlers for a refund, by-passing the retail level. Reusable bottles include proprietary food jars, wine/spirit bottles and those with standard necks, all previously considered recyclable as cullet. Reusable bottles, sold in resale outlets attached to curbside program or collection center sites, are bought by home canners and amateur wine makers. Alternatively, reusable bottles are sold to the new bottle washing industry for resale to food and beverage bottlers. In one case a group uses glass bottles as lamp bases in a craft operation linked to their own resale outlet.

D. "Tin" Cans:

For ultimate use in the copper mining and steel industries, prices vary with contaminant removal and presence of aluminum. Some source separation programs are paid nothing for this fraction and others receive as much as \$15/ton.

E. Aluminum Cans, Pie Plates and Foil:

For recycling into containers and other products, when aluminum is separated from ferrous metals, prices range from \$10-\$15/pound, and are paid to individuals, source separation programs, and dealers. In the U.S., beverage cans are 38% of residential waste aluminum. (4)

F. White Goods:

Discarded water heaters, stoves, fridges and other large appliances are sold, exchanged or given away at program site resale store outlets. Alternatively, they are sold to scrap dealers. (Mobile and satellite source separation programs sometimes consider themselves to be a market for discarded 55 gallon drums which are useful in their collection operations.)

G. Plastic:

Collection and use of residential waste plastic appears to be limited. Plastic food containers are used in the manufacture of weatherproof boards in England and of toys in the western U.S. Clean polyethylene is sold in England to refuse bag manufacturers.

H. Paper:

Over fifty grades of paper are reclaimed in the U.S. for many different uses such as newsprint, corrugated cardboard, building materials, insulation, container board, fine paper and hygiene papers. Of significance are the number of low grade papers acceptable to the building materials industry for such products as asphalt roofing shingles, insulite board and compressed board. Consequently, grades including mixed paper, magazines, junk mail, and egg cartons are commanding around \$30/ton in some locations. Hopes for a new animal bedding market for newspaper hinge on scientific research into the effect of printing chemicals on animals who eat some 25% of their bedding.

There is a vigorous newspaper export market for west coast U.S. and Canadian source separation programs, despite charges that this activity is unpatriotic for Americans. The Recycling Council of British Columbia's exporting activities have been criticized as solving only one half of the problem by diverting waste from disposal but not conserving through domestic reprocessing. Export markets are subject to cyclical factors affecting the world economy. Some foreign countries are trying to stimulate domestic recycling by raising import duties and there is some concern about "dumping" among the importers. This export market includes countries such as Sweden, Japan, Korea, Taiwan, Hong Kong, Philippines and Australia. (5)

Prices for waste newspaper destined for recycled newsprint and cellulose insulation vary with contamination and other qualities (wet/sunburnt). In the U.S. there is a publication called the Official Board Markets (OBM) which lists paper prices in ten major centers. Many municipalities, groups, and dealers have long-term (1-3 year) contracts to supply paper for a percentage of OBM prices plus an additional price per ton extra for sorted material. These contracts take into consideration the cost of containers provided by buyers. Several source separation programs collect and sell corrugated cardboard from businesses, and high grade papers from offices. In most cases these activities (carried on in addition to residential programs) bring in revenue, but in other cases collections are operated at a loss, for public relations purposes.

I. Combination Fractions:

In some programs, fully or partially mixed recyclable fractions are sold to dealers or intermediate processors who separate and resell the component fractions. When asked whether there were any innovative trends in new fractions, a western state official replied that the only new fractions are mixtures of old ones.(6) In other words, when fractions are co-mingled at the residential collection point, the combination is perceived as an entirely new collectable fraction. Thus, the fraction collected in Downey, California is glass-cans-paper. In Marblehead, the three fractions are mixed paper, cans-clear glass, and cans-coloured glass.

J. Miscellaneous Fractions:

Mostly sold at resale outlets associated with program central sites, are several low throughput materials such as clothing, furniture, and bottles/jars mentioned above. Some groups collect rags, car batteries, tires and motor oil for resale to dealers and local industries. (A curbside compost collection, started by an ORE-type operation on the west coast, was forced to close down by health authorities. Home composting is preferred and promoted by many groups.) These unusual fractions are collected by volunteer and non-profit groups which offer a wide range of services, and almost never by municipal or private hauler program sponsors. Successful scientific research on the use of rubber tire material in road surfacing mixtures other than simple coating sprays may boost the marketability of auto tires.

6.3.3 Some Illustrations of Innovations in Materials Collected and Resold

A. Nottingham System:

The proliferation of rural collection centres modelled after the Nottingham, New Hampshire prototype, is described in detail in Section 8. In the town of Nottingham, where refuse incineration is combined with collection of recyclables at the centre, a goal is to divert as much non-combustible material as possible from the incinerator. The age-old habit of "dump picking" has been made more efficient and safe for users by the establishment of a special shed for discarded items that may be useful to others. Items are taken for "free".

As second-generation Nottingham-type programs are implemented in New England, home composting is recommended. A disposal cost of \$15 per capita is associated with recycling-incineration centres which allow wet food and brush to be mixed with combustible refuse. This cost can be reduced to \$6 per capita due to more efficient pyrolytic incineration when compostables are removed. (7) An exception to the recommendation for home composting is found in one new centre which proposes to collect compostable refuse, and resell the compost product to collection centre patrons for \$35/ton.

In Meredith, New Hampshire, a Nottingham-type program, rubber tires are accepted at the collection centre. It is estimated that 40% of locally discarded tires are recappable. Tires are sold to a local retreader. (8)

B. Arrowhead:

Project Arrowhead in Duluth, Minnesota, has a confidential records shredding operation, a service in high demand because of local pollution regulations against office paper incineration. Besides the \$40/ton revenue from this service, they receive \$60/ton when the paper is sold.

Whenever this group hauls its glass to market, on their return trip they stop at the local Reynolds (aluminum) Metals plant to pick up ferrous rejects from magnetic separation. This "ferrous" includes 15% aluminum and is taken to Arrowhead's warehouse for further separation with the resulting aluminum sold back to Reynolds! Arrowhead started collecting cereal boxes and junk mail as a public relations gesture but now receives \$33/ton for the material from an insulite board maker who also purchases their waste magazines. (9)

C. West Coast:

"Encore" is the name for the Berkeley, California bottle washing plant, an operation spreading throughout the west and southwest U.S. Dependent on good local demand, these new businesses wash food and beverage bottles for resale to wineries and food processors. The concept had to be sold to bottlers by the entrepreneurs who are now a major market for west coast volunteer, municipal and commercial source separation programs in which glass is collected. (10)

The Portland Recycling Team in Portland, Oregon is able to include plastic food containers among collectable fractions because the country's largest frisby manufacturer buys extrudable post-consumer waste plastic. (11)

There is a general trend on the U.S. west coast toward the creation of waste exchanges and buy-back centres. In buy-back centres, program sponsors pay residents for materials delivered. Thus, some non-profit source separation programs are adopting dealer and broker roles.

D. General Concern for Local Economic Growth in the U.S.:

Creation of employment opportunities is at the top of the priority list for many groups who hope to stimulate local oil re-refining, insulation and bottle washing businesses as alternatives to shipping materials to distant markets. While there is some suspicion that the cellulose market is drying up (a negative economy because customers do not come back), source separation programs are enjoying the "boom" before the "bust".

E. England:

Oxfam's WasteSaver Program in Kirklees, U.K. is a prime example of a vertically integrated source separation program. Oxfam is its own market. Many fractions are processed for resale to industry including rags, plastics, paper, glass and metal. But Oxfam has craft and reconditioning workshops culminating in the retailing of toys, furniture, clothing, appliances, stamps, books and linen. (12)

6.4 Marketing Techniques

Source separation programs are emerging from their environmental infancy into serious business operations. Except for the most bald profit-making ventures (charity drives and dealers capitalizing on high paper price periods), programs are still environmentally motivated and proponents cringe when financial viability is the only yardstick of success. But there is universal agreement that a keen business sense is essential to the development of source separation programs.

6.4.1 Intermediary and Cooperative Mechanisms

Improved marketing techniques are one of the manifestations of an advancing state of the art. Two structural innovations have emerged.

First, there is the appearance of intermediate processors on the far east and west U.S. coasts. Intermediate processors are discussed in detail in Section 10. These businesses upgrade and market materials bought from source separation programs. Thus, collection program sponsors are released from market search tasks.

Second, there is the growth of cooperative marketing on the west coast. Cooperative marketing is done by several coordinating bodies of federated source separation programs such as the Recycling Council of British Columbia, the Portland Recycling Team, and the Santa Barbara Resource Recovery Program. Each of these has amassed marketing expertise over several years and now helps sustain source separate collection programs by improving their bargaining position with markets.

With the growth of both cooperative and intermediary marketing mechanisms as a "recycling service sector", new and proposed source separation programs can short-circuit the market research stage. The intermediate processors differ from conventional dealers by buying several or all fractions collected in a number of supplying programs. They resemble dealers by processing and reselling fractions to secondary materials users. Cooperative marketing agencies resemble brokers who arrange sales but never come into contact with materials.

Managing high volumes of materials, both marketers (that is, intermediate processors and cooperative marketing groups) can secure markets that would be harder to obtain with small volumes from individual source separation programs. These marketers can act as buffers: they protect individual programs from fluctuations in demand by rerouting materials to various buyers as needed. (The system is not foolproof. For example, one intermediate processor in New England can no longer re-sell colour mixed glass. His suppliers are forced to either drop coloured glass or ask householders to start sorting glass, because the intermediate processor has no facilities for sorting colour mixed glass.)

6.4.2 Market Research

Regardless of whom undertakes market research, a number of steps are standard now in significant programs and these are outlined as follows:

A. Estimation of Generation and Composition of Recyclables:

These estimates are essential for several reasons. Estimates are used to develop economic projections for the system on a cost-benefit basis. Tonnage estimates are necessary for initial approaches to materials buyers. Also, the collection system must be designed with the capacity to handle estimated recyclable amounts.

The ease of arriving at these estimates varies with the availability of local data and the kind of source separation program proposed. In depot programs, a catchment area can be established by publicity boundaries. In curbside programs, the number of households to be served is a matter of establishing collection beats, minus areas to be excluded such as apartments and commercial areas. It is ideal where local engineering estimates exist for residential waste generation, and better still where waste estimates can be broken down into proportions of glass, metal and paper. In the U.S., when local estimates are not available, national averages are used with allowances for local idiosyncrasies such as container legislation, cosmopolitan readership of papers and existing reclamation activities.

In newspaper collection programs, local and regional publishers are often contacted for circulation and tonnage figures to arrive at an estimate of potentially recoverable paper. For planning collection beat size, collection time per beat and vehicle capacity, it is desirable to know average household recyclables generation. Census data for average family size per household multiplied by per capita generation allows the calculation of expected amounts at various time intervals (per week, per month), next multiplied by expected participation or various participation rates. (Compared to other jurisdictions, Ontario appears to be advanced in having a data base for estimating per capita waste generation as a result Waste Management Advisory Board work.)

B. Market Surveys:

Whether done by phone or letter, the following questions are asked of local and distant buyers:

- 1) Price as a function of material condition: It is important to know what contamination is tolerated by the buyer and how this will affect prices paid. (The trade-off between the excellence of materials preparation and householder participation is detailed in Section 10.)
- 2) Specification for material preparation: This is related to the need for in-program processing (upgrading and volume reduction: baling, bundling, flattening, crushing, sorting). Minimum tonnages are often stipulated.
- 3) Quantity that can be consumed and "end use": Commitment to a source separation program requires reliability of demand for collected materials. To this end, programs investigate the reputability of a buyer, especially companies making cellulose insulation. Seasonal variations for paper markets and commodity shifts for metal can markets are also a concern. When investigating buyers, sponsors of significant programs seek assurances that dealers/users are not vulnerable to demand fluctuations that occur in further market linkages. For instance, to take an extreme case, a lower price offered by a paperstock dealer supplying various other industries, may be chosen over a high price offered by a cellulose insulation company with seasonal peaks and changes in product demand. Cooperative marketing techniques can surmount this fluctuation problem by rerouting materials according to demand. For instance, west coast groups switch to export paper markets when domestic demand and prices wane.
- 4) Containers and processing equipment available: Some buyers supply metal and/or glass crushers for volume reduction, and bins for material storage before transportation to market. While these services reduce in-program expenditures, lower materials revenues may be expected -- another trade-off.
- 5) Transportation arrangements: A key question asked of buyers is price as a function of materials delivery, i.e., freight on board (f.o.b.). Prices for materials are generally lower when a buyer picks up recyclables but this may be a more cost-effective option than delivering materials to market. Along with container provision, transportation services also reduce flexibility to change markets.
- 6) Contracts: Availability of long-term contracts with guaranteed floor prices and escalator clauses for peak price periods is an advantage that varies with recyclable fraction and region.

C. Comparison of Revenues with Costs:

The decision-making process is simplified if markets for materials are not found in the above process. Thus, in some programs, fractions initially considered for collection are dropped from consideration. The decision-making process is also simplified if there is an obvious "best deal" or if there is only one possible market for a fraction; however, rigorous weighing of advantages and disadvantages is usually necessary. There are two chief questions. The first relates to materials preparation requirements, the second to transportation.

First, stringent materials preparation requirements may depress household participation or require in-program processing. Most source separation programs opt for higher participation even if lower prices accrue to contaminated materials.

Second is the transportation question. Determination of economic hauling distances is especially critical for rural areas where revenues rarely offset costs of transport. In all programs, even when transportation service is offered by the buyer, investigation must be made into the best mode of hauling. Source separation programs look at rail and truck haul as well as less reliable but cheaper back-hauls and charity hauls. Haulers' stipulations for minimum tonnages involve storage and volume reduction considerations. Consequently, for each fraction, program sponsors compare the following transportation factors:

- destination
- revenue per load
- mode (rail, ship, truck)
- physical loading capabilities of program site (compatibility with mode)
- minimum tonnage
- hauling rate
- cost per load

A destination may be ruled out simply because of an off-loading problem. In-program facilities may not be adequate for storage over long periods when minimum rail/truck tonnage requirements are coupled with low throughput. But the critical question is how revenues per load relate to cost per load. Significant source separation programs are approaching transportation systems in a very business-like manner, calculating feasible hauling distances, and often seeking the advice of commercial hauling businesses.

6.4.3 Negotiating Contracts

Despite the fact that market assessment of alternatives is a continuing process, the last step in marketing is to solicit letters of intent to bid during pilot programs and negotiate purchase contracts once quality control of materials is established. The U.S. EPA implementation manual is appended with sample contractual agreements, indicating the importance of this activity.

6.4.4 Illustrations of Marketing Considerations

To highlight previous points, several illustrations from two source separation programs appear below. From San Luis Obispo, a commercial hauler program, Table 3 shows how generation estimates are used to project revenues, and Table 4 lists contractual specifications of chosen markets. In this program, favourable prices and hauling distances are the two main criteria for choice of markets. (13) From Helena, Montana, a municipal paper collection program, Table 5 shows a comparison of shipping rates, and Table 6 is an abridged market survey chart where long-term and local markets are priorities. (14) (These four tables are reproduced from their sources. Minor changes in layout and in the wording of headings and a footnote have been made in order to make these tables understandable outside of their contexts.)

TABLE 3: WASTE GENERATION, RECOVERY AND PRICE PROJECTIONS FOR SAN LUIS OBISPO, CALIFORNIA

Commodity	Estimated daily Tonnage available*	Range of Participation, %	Range of Tonnage	High Market Price, \$/Ton	Total Projected Revenue, \$/week			
					20%	30%	40%	50%
Newspaper	5	20-50	1-2.5	\$45	315	477	30	787
Glass	2.8	20-50	0.6-1.6	\$15†	63	84	126	168
Mixed Fe-NFe	3.5	20-50	0.7-1.7	\$35	171	245	342	416
TOTAL (range)		20-50			549	806	1,098	1,371

* Assuming 50% coverage of residences and assuming that 70% of the disposal contractor's solid waste is generated by residential customers.

† FOB San Luis Obispo.

TABLE 4: BUYER AGREEMENT SPECIFICATIONS OF MARKETS CHOSEN FOR SAN LUIS OBISPO

Material	Buyer	Price	Material Spec.	Transportation
Newspaper	Garden State Paper Co. Pomona, CA	\$25/ton, floor \$45/ton initial	Clean, No String, Bags etc.	fob Pomona, CA
Mixed Metal	Ecolo-Haul Pacific Palisades, CA	\$35/ton + adjustment for aluminum content	Crushed (will supply crusher)	fob Gardena, CA
Mixed Glass	Circle Fresno, CA	\$15/ton	No Ceramics	fob San Luis Obispo
High Grade Paper	Independent Paper Stock Long Beach, CA	\$80/ton	Loose	fob Long Beach

TABLE 5: OPTIMAL SHIPPING RATES TO POTENTIAL MARKETS* CONSIDERED FOR HELENA, MONTANA

Destination	Mode	Rate	Cost/Load
Great Falls	Truck	Purchaser Will Provide Shipping	
Missoula	Truck	Purchaser Will Provide Shipping	
Billings, MT	Truck	Purchaser Will Provide Shipping	
Seattle, WA	Rail	\$1.18/100 lbs. (25 tons minimum)	\$590
Spokane, WA	Rail	\$1.15/100 lbs. (25 tons minimum)	\$575
Salt Lake City, UT	Rail	\$2.02/100 lbs. (18 ton minimum)	\$727
Boise, ID	Truck	Purchaser Will Provide Shipping	

* Excluding possible backhaul and charity haul rates.

TABLE 6: POTENTIAL MARKETS IDENTIFIED IN THE MARKET SURVEY FOR HELENA, MONTANA

Company and Location	Utilization of Recycled Newspaper	Tonnage		Shipment		Contract Arrangements
		*Price/Ton	Minimum	Preparation	Delivery	
MONTANA All Weather Insulation 2109 Vaughn Road Great Falls, MT 59601	Manufacturer of cellulose fiber insulation; seeking UL approval for product	\$50-\$70	5-10 ton lots	Bundled(-20 lb/bundle), or baled(-1,000lb/bale)	Buyer responsible; Helena provides labor and dock for loading	Long Term (Yearly renewal); possible base price with allowance for upward increases
Thermo-Sheild Insulation 3811 First Avenue South Billings, MT 59101	Manufacturer of cellulose fiber insulation; product has UL rating	\$40-\$50	None	Bundled or baled	Buyer responsible; trailer at landfill and ship full	Long term (1-3 years) with price negotiable; \$40 base and negotiable upward
OUT-OF-STATE Ideal Paper Stock Company 9 South Massachusetts Seattle, WA 98134	Manufacturer of recycled paper products(?)	\$40-\$60	40 ton lot	Bundled or palletized	Negotiable; railroad mode suggested	Long term with price based on market shipment time
Spokane Recycling Products East 3407 Main Avenue Spokane, WA 99202	Collection Center for shipment to paper mills	\$40	20 ton lot	Baled or palletized	F.O.B. Spokane (Helena responsible)	Long term (3 years) with price tied to Official Board Market quotes (W. Coast)

6.5 Summary and Conclusions

Marketing is the kingpin of source separation. Generally, there is optimism that present and future resource shortages and price hikes are likely to increase demand for source separated recyclables. Yet, market revenues remain low in most regions and impede the financial attractiveness of source separation.

In other jurisdictions, several significant advances in the marketability of materials have been identified. Basically, marketability is being advanced by increases in demand for materials, by improvements in the quality and quantity of materials supplied, and by more professional marketing techniques. While some of the trends in other jurisdictions are not applicable to Ontario, several could be explored for adaptation here.

- The newspaper recycling industry in the U.S. appears to be the single most dramatic trend in boosting demand for source separated newspaper in regions where the several de-inking plants are located. The viability of these plants is enhanced by domestic virgin pulp shortages, acceptability of the recycled product, and large supply catchment areas served by backhaul.
- Other trends in increased waste paper demand include the acceptability of mixed paper grades in areas where there are building materials manufacturers, and the availability to west coast programs of export markets.
- Demand for glass cullet in the U.S. has been hampered in some regions by the glass industry's resistance to accepting unprocessed glass, and its hesitation to inconveniencing the public with separation responsibilities in light of competition with the can industry; however, savings to the industry in terms of pollution, energy, and maintenance, are making use of post-consumer waste more attractive. The appearance of east and west coast "intermediate processors," which prepare kiln-ready cullet, is also making source separated glass more attractive to the industry. At least one example of government action was found in which a glass plant agreed to boost waste cullet use as an alternative to installing pollution control equipment.
- Another trend in the demand for waste glass includes the acceptability of reusable glass bottles on the west coast where a number of bottle washing plants, which supply wineries and food processing plants, have been established.

- The existence of local breweries which use refillable bottles, and the more recent implementation of returnable beverage container legislation, both stimulate the marketability of refillable and/or recyclable glass containers in some states.
- The establishment of resale outlets attached to source separation program sites is a form of "vertical integration" in which programs market materials directly to the public. It appears that interest in hobby wine making and home canning accounts for the patronage of outlets which offer used glass containers. A more comprehensive product range is offered by an English charity which integrates collection, processing workshops, and resale of craft goods. A more specialized product is offered by a western Canadian program which integrates waste newspaper collection, insulation manufacturing, and resale.
- Demand for waste aluminum in the U.S. is strong. Marketability of cans is vigorously aided by aluminum manufacturers who are eager to combat container legislation and recoup energy savings.
- Demand for mixed types of source separated materials has been made possible by "intermediate processors" which separate and resell the various components. Thus, in certain coastal regions of the U.S., fully or partially co-mingled cans/glass/paper are marketable for source separation programs.
- In certain regions, demand for materials and services aids the marketability of certain miscellaneous fractions. Thus, waste oil, plastics, compostables, and recappable tires are collected and marketed in some areas. In at least one case studied, confidential records are shredded and resold by a primarily residential source separation program.
- Improvements in the reliability of supply are occurring through innovative dealing and brokering structures. The northeast U.S. "intermediate processors" are multi-material dealers. The various forms of collective or cooperative marketing agencies on the west coast are multi-material brokers. These new dealers and brokers are stimulating supply by absorbing the burden of marketing previously performed by individual source separation programs; by rerouting materials according to market demand and therefore buffering individual programs from fluctuations in price; and by controlling a high volume of supply and therefore improving the bargaining position of individual programs which, with their small volumes, would have difficulty in securing markets. In other words, the existence of this form of dealing and brokering marks the appearance of a "marketing service sector" which helps to sustain

supply mechanisms. This quantity of pooled supply, and especially the improved quality of processed material supplied, in turn help to strengthen demand.

- Another related development on the supply side is the increasing interest of residential source separation programs in commercial, institutional, and industrial waste materials. Office paper, retail corrugated board, and restaurant glass are, in some cases, collected and marketed. These other materials are often cleaner as collected and can attract higher revenues than the conventional residential fractions. Thus, the marketability of these non-residential materials provides a subsidy and helps to sustain the supply mechanisms in general.

- In addition to the advances made by the "service sector" referred to above, marketability has been advanced by an emphasis on systematic marketing procedures. Significant programs are characterized by a marketing stage which includes estimation of recyclables generation, economic hauling modes and distances, reliability of demand, as well as negotiation of contracts--all businesslike techniques not associated with earlier source separation history.

The above trends suggest areas for further exploration in Ontario:

- In addition to technological research into new and expanded uses for source separated materials, consideration should be given to developing financial incentive and/or subsidy schemes for industries which can begin to consume or expand consumption of secondary materials, especially waste fibres, glass, and plastics.

- Stimulation of a bottle washing industry may have merit. Bottle washing plants on the U.S. west coast buy reusable glass containers from source separation programs. But in Ontario, an independent bottle washing industry should be carefully considered in light of other waste management options such as the return of standard bottles to points of purchase with washing performed by the bottle using industries.

- The establishment of resale outlets, compost farms, refurbishing workshops, and product reprocessing (e.g. confidential records shredding) could be encouraged in source separation program designs if such activities are locally appropriate.

- A "materials marketing service sector" should be encouraged. A multi-material brokerage should be able to offer both written and more responsive, spoken information on marketing. A multi-material dealership would have, in addition to software marketing services,

the hardware facilities to produce quality material. A brokerage/dealership would be able to pool small volumes and boost the reliability of supply and demand.

- The addition of marketable, non-residential high-grade materials should be encouraged in source separation program designs.

- Professional, businesslike marketing procedures should be promoted as key in any source separation program.

- As the logistics and economics of hauling materials to market are factors in the marketability of materials, transportation research is warranted. The use of backhaul for more remote regions in Ontario appears to be unexploited for source separation. Research could be conducted on developing an Ontario-wide transportation system which would move shipments from cooperating source separation programs to non-local markets.

- Several of the U.S. trends do not appear to be applicable to the Ontario situation. As the Ontario residential waste stream has a low aluminum can composition, the marketability of at-source residential waste aluminum is not a strong concern. As the practice of source separating glass from metal, and glass and metal from paper, appears to be well established, the marketability of fully or partially co-mingled materials would not be a priority concern. Similarly, the marketability, for source separation programs, of refundable containers, has little relevance if the trend toward consumer return of refillables to the point of purchase is to be maintained.

SECTION 7

VEHICLES USED IN SOURCE SEPARATION PROGRAMS, AND RELATED KEY COLLECTION DECISIONS7.1 Introduction

Significant design innovations are found in vehicles used for source separate curbside collection; however, beyond the collection stage in curbside programs, and in various stages of drop-off centre programs, conventional vehicles are used for transfer, handling and hauling of recyclables. The latter vehicles will be called post-collection vehicles in order to distinguish them from curbside collection vehicles in the following discussion. The use of post-collection vehicles will be examined first.

7.2 Post-Collection Vehicles

Post-collection vehicles consist of a variety of vans, bulk-lift container trucks, packers, stake and flat bed trucks, and trailers. These are used for off-route transfer, bin and satellite servicing, and hauling to market. Ordinary fork lifts, front loaders, and bulldozers are used for moving materials at central handling sites. There is no general rule for what type, and whether a post-collection vehicle is used. This depends on:

- Number, kinds and tonnages of fractions moved
- Type and capacity of the collection vehicle used
- Whether off-loading from collection vehicles is done mechanically or manually
- On- and off-loading facilities at the central program site and at the buyer's site
- Availability of existing or leased equipment for private and municipal haulers, and donated or "make do" vehicles for non-profit and volunteer groups
- How and when materials are delivered to market (If recyclables are delivered directly to local markets by collection vehicles or if collection vehicles off-load directly into bulk storage containers provided and picked up by buyers, very little extra equipment is necessary)

To illustrate the above variations, several examples will be useful.

In the City of Sacramento, if packer truck racks fill with newspaper before the refuse routes are finished, then vans are used to transfer newspaper from on-route collection vehicles to a newspaper handling building at the landfill site. As racks do not often fill before the packer itself, municipal officials claim that expensive transfer vans can be discontinued, resulting in a net profit situation for the newspaper collection program. (1)

In contrast, Cloudburst Recycling, Inc., an ORE Plan-based business in Portland, Oregon, parks a large storage van in neighbourhoods receiving multi-material curbside collection from a small pickup truck. Proponents of the scheme claim that collection costs and gasoline consumption are reduced because a small vehicle performs collection without having to transport recyclables to a central site each time capacity is reached. (2)

For another example, most New Hampshire towns that combine reclamation with disposal at collection centers are provided with bulk containers for storage of recyclables by materials buyers or haulers. Conventional trucks pick up these containers, cutting hauling costs for the towns. The disadvantages of this arrangement are lower market prices and inability to change markets. (3) On the other hand, Arcata Community Recycling Center in northern California, hauls several fractions to distant markets. A large flatbed truck with a hydraulic tail gate is used for maximum flexibility in moving either baled paper or 55 gallon drums of glass and metal to market. (4)

Vehicles employed beyond the point of collection are conventional in design. Their use depends entirely on other components of the source separation program. For these two reasons the rest of this section deals exclusively with collection vehicles.

7.3 Collection Vehicle Design Considerations

The state of the art for source separate collection vehicles is in its infancy in two respects. First, there appear to be no known and proven designs for multi-material collection. No existing custom-designed trucks have been adopted on a wide scale and therefore their use has not been demonstrated under varying conditions. Second, given existing vehicle designs and pilot scheme data, there is no set formula for determining what vehicle is performance- or cost-effective outside of a specific program. (5)

The collection vehicle question is crucial from a cost point of view in a curbside program. Fractions of a second per collection stop can make the difference between a break-even/revenue-generating program and one that operates in the red. Furthermore, a collection vehicle cannot be chosen for its cost-effectiveness without regard for what the vehicle is expected to do. That is, vehicle design is therefore a function of many other components of a source separation program, as outlined below.

7.3.1 Collection Conditions

Vehicle design decisions are not made in isolation from decisions about what recyclables are collected and when recyclables are collected. In other words, among programs examined in this study, the following conditions are associated with vehicle design:

- Number of fractions collected
(single-vs.multi-material)
- Kind of fractions collected
(paper, glass including 3 colours,metal)
- Processing activities carried out within
the program or by an intermediate processor
(Section 10)
- Simultaneous or non-simultaneous collection
of refuse and recyclables
- Simultaneous or non-simultaneous collection
of different recyclables in multi-material
collections (In the "single pass" system,
all fractions are picked up at participating
households at the same time and in the same
truck. In the "multiple pass" system, each
fraction is picked up at a different time.)

The basic vehicle designs for curbside collection are listed below in Table 7 with conditions for use specified.

Table 7: Source Separate Curbside Collection Vehicle Designs and Conditions for Use

VEHICLE DESIGNS	CONDITIONS FOR USE
<ul style="list-style-type: none"> - normal packer - large flatbed or stake truck - pickup truck with raised sides - enclosed van 	<ul style="list-style-type: none"> - single fraction collected, usually newspaper - several fractions collected simultaneously (single-pass) and co-mingled because of the availability of an intermediate processor - several fractions collected, non-simultaneously (multiple pass) - recyclables not picked up simultaneously with refuse
<ul style="list-style-type: none"> - packer truck adapted with one compartment or fitted with racks - packer hauling trailer 	<ul style="list-style-type: none"> - one fraction, usually newspaper, collected simultaneously with regular trash
<ul style="list-style-type: none"> - multi-compartmentalized special vehicles - pickup trucks hauling container train - vans or flatbed trucks with drums or partitions 	<ul style="list-style-type: none"> - several fractions collected simultaneously but not co-mingled or only partly co-mingled - recyclables not picked up in same vehicle as refuse
<ul style="list-style-type: none"> - packer truck equipped with racks and other compartments 	<ul style="list-style-type: none"> - multi-material, non co-mingled recyclables collected on same day and in same vehicle as refuse

This list is useful for choosing a vehicle if conditions for use are known. In the last two categories, compartments must be designed according to number and proportions of fractions collected, therefore local recyclables generation and composition data must be assessed.

7.3.2 Capacity (Size)

Vehicle size is calculated with recyclables generation (amounts) and composition (proportion) levels, as well as participation and recovery levels, in mind. (Participation and recovery rates are related but not synonymous, as discussed Section 11). Under certain conditions smaller vehicles fill quickly, necessitating more trips to an off-route transfer point, a central (disposal) facility, or a local market. The same concern arises for compactors fitted with racks for newspapers.

Following is a list of circumstances which affect vehicle fill-rate. A fast fill-rate may necessitate either larger trucks, or smaller trucks with local off-loading facilities, or smaller trucks with more trips to distant central facilities. There is unresolved debate about the above trade-off related to vehicle size: more frequent off-route transfer by small trucks which consume less gas vs. less frequent off-route trips by large trucks which consume more gas. Vehicles may fill more quickly under the following circumstances:

- Less frequent collection (when householders store recyclables over longer periods, amounts per pickup will be greater than for more frequent pickups, but total tonnage will be less because long storage is associated with lower recovery)
- High density residential areas (may have more homes per route than low density areas but may have lower socioeconomic status and thus lower yields)
- High participation and/or recovery rates (but this need not imply large tonnages per pickup if collection is frequent)
- High socioeconomic status
- Larger collection area
- Evolution from pilot project to full scale program
- Fewer preparation requirements for householders (where only newspaper is collected or where all fractions are co-mingled or partly co-mingled, data indicate higher participation and/or recovery)
- seasonal variations (as for glass at holiday times)

These eight variables are sometimes interdependent and are linked with the conditions under which vehicles are used as discussed above (in 7.3.1). (A detailed discussion of three questions appears in Section 11: frequency of collection; simultaneous collection of recyclables and refuse; simultaneous collection of several recyclable fractions.)

7.3.3 Cost

There are three major cost factors that impact on vehicle design choice. First, market price for collected materials is a factor if high revenues can "justify" capital expenditures for new equipment. When revenue projections are low, program sponsors may not be able to afford the most efficient vehicle. A second factor, related to the first, is the availability of funding programs (grants, loans, subsidies) which can be tapped for financing costly vehicles.

Third, methods of cost allocation affect the apparent attractiveness of vehicles. The same vehicle may be financially acceptable or unacceptable depending on which accounting technique is employed to amortize and allocate equipment costs. If, for instance, in a municipal or commercial refuse hauler source separation program, a packer is pulled from a reserve equipment pool for curbside collection of recyclables, there are four different ways of allocating the truck costs:

- All costs (depreciation, fuel, maintenance, etc.) in proportion to time spent on separate collection by the packer
- All costs, not proportionate, as if the packer was only used for separate collection, and no longer available for refuse collection
- No costs because the packer is already budgeted under refuse collection
- Some costs such as fuel and maintenance costs incurred in separate collection but not depreciation because the packer would depreciate regardless of source separation.

Taken together, material revenues, funding and cost allocation are key in determining 1.) whether existing vehicles should be structurally adapted, 2.) whether surplus trucks that exist, either because of absolute excess capacity or because temporary excess occurs on special pickup/yard waste/white goods days, should be utilized, or 3.) whether investment in new equipment should be considered. If participation/recovery jumps for one or a combination of the eight reasons mentioned above (7.3.2), especially the change from pilot to full scale program, a crucial question will arise--this is whether borrowed or modified conventional refuse vehicles can absorb the incremental time and tonnage created by the expanded source separation program.

7.3.4 Weather, Terrain and Labour

Three final considerations must be mentioned. Local weather and terrain conditions will vary the need for vehicle cover protection, and durability. The point of collection is a consideration because laneway pickups and curbside collections on traffic-crammed urban streets may be better accomplished by smaller, more maneuverable trucks. Labour must also be taken into consideration for two reasons. One is that collection workers and/or unions dislike trailers hitched to packers. Second, crew size is an expense factor. Low cab, side loaders with right hand side driving controls, and some other small vehicles may require one driver/collector. Flat bed trucks with or without drums/partitions usually require three persons to drive, collect and sort/stack. Packers, container trains totes by pickups, and compartmentalized vehicles can be staffed by two persons (Note: Some municipalities allow vehicles to be over-staffed because of labour relations problems). The relationship between labour and equipment requirements is discussed further in Section 5.

7.4 Specific Collection Vehicle Examples

It will be useful to discuss some examples of collection vehicles for which test results and/or performance estimates exist. Several vehicles are being or have been tested in the United States. In every case examined, vehicle choice is tailored to local conditions and many attempts have been made to streamline vehicle operation in order to cut costs. Sketches of some of these vehicles appear at the end of this section.

Vehicle designs fall into four categories:

- Existing Equipment Unmodified
- Existing Equipment Modified
- Special Combinations of Existing Equipment
- Specially Designed New Equipment

7.4.1 Existing Equipment Unmodified

Conventional packer trucks and unpartitioned trucks are generally used for separate truck collections of a single recyclable fraction. This is a cost-effective option when such equipment is already owned by municipal or private haulers and can be diverted from refuse collection, or is underused on special pickup days for yard waste and "white goods". Such trucks are also used for multi-material collections when the multiple pass system is used to pick up each fraction separately. This is less cost-effective than a single pass system, as more labour, vehicle miles and fuel are required.

The use of unmodified existing vehicles seems to be most suitable when the following conditions exist: high participation/recovery, large collection area, surplus equipment and labour, single recyclable fraction collected or multiple pass system used, and financial unattractiveness of modifying or purchasing additional equipment.

In an early engineering study of eleven municipal and six commercial and ecology group programs, an economic evaluation showed that the impact of separate truck collection on the total waste collection system varied with market revenues. Program startup costs were negligible. Under typical revenue conditions, the source separate truck subsystem reduced total waste collection costs by 7%. In the cases studied if separate collection crew size had been reduced and refuse routes revamped because of diverted waste, savings would have been even greater as long as participation rates reached 30%-40%. (6) Most of these trucks were unmodified designs.

7.4.2 Existing Equipment Modified

A. Rack

Conventional packer trucks fitted with racks are widely used for newspaper collections in the United States. This system is attractive because refuse and paper can be collected simultaneously. Residents' set-out habits do not have to be altered nor do complicated pickup schedules have to be remembered. Racks are made and installed under and behind packers for between \$80 and \$250 each (1974 prices) and have capacities of 0.5-1.25 cu yd; however, the packer design, and maximum vehicle width regulations may prevent the use of racks.

Technical problems have arisen with racks. Racks may fill before the body of the truck. Two options are used to overcome this problem. Racks are either off-loaded into prepositioned containers and trucks, or excess paper is compacted with trash. Associated with rack over-fill, and arising also when racks are off-loaded at a central facility, are the incremental time and labour requirements of the approach. If participation/recovery rates become too high, time spent off-route and off-loading may prevent rack-fitted packers from finishing their normal trash routes.

In the same engineering study mentioned above, a simulation model developed for the rack system case histories, showed that at low participation/recovery rates incremental time requirements were off-set by revenues and diverted disposal credits. As participation/recovery rose, additional time required for pickups, transfer of over-fill, and off-loading (and associated additional vehicle and labour requirements) was not off-set by revenue. Nevertheless rack newspaper collection lessened total collection system costs by 3% in five rack systems studied. (7)

In contrast with the separate truck approach cited above (7.4.1), the suitability of rack collection is associated with a low participation rate, small community size and lack of surplus equipment and labour. As in the separate truck approach, only one recyclable fraction, mainly paper is collected in racks. The rack approach eliminates the need to purchase extra or specialized equipment.

To illustrate the advantages of the rack approach, it is helpful to look at an engineering study commissioned by a paper buyer to solve problems in the collection system of a supplying municipality. The City of San Diego used separate trucks to pick up newspapers once per week from 180,000 households. Scavengers picked up about one-third of the separated tonnage, collection crews were partly financed by federal funds for job-creation, and market prices were \$25/ton. Under these conditions the separate truck approach averaged a \$30-\$57 cost per ton for an average 400-700 tons per month recovered. The program was going to be discontinued due to withdrawal of federal labour funds. Several non-technical changes could have brought the program into a break-even situation: greater participation, effective enforcement of the anti-scavenger ordinance or a newspaper price of \$30-35/ton, but by changing to a rack approach, none of these changes would need to be implemented for the program to be cost-effective.

In San Diego several alternative vehicle approaches were evaluated: 1.) a 1-ton stake body truck with raised sides and hydraulic dumping system; 2.) a 3/4-ton pickup truck with an attached hydraulic dumping trailer; 3.) a 25-cu yd. rear-loading packer, and 4.) a 3/4-ton pickup truck with raised sides, (the same vehicle then in use for separate collection, but with a smaller crew). A fifth option was chosen. This was the mounting of 1-cu yd. racks above hoppers on existing rear-loading packer trucks along with three mobile transfer units for capacity-filled racks (3/4-ton pickup trucks with 20-cu yd. trailers). On an incremental cost allocation basis where the separate collection subsystem was assessed for its impact on total collection system costs, the proposed approach would have had an estimated incremental operating cost of \$10-\$19/ton of newspaper. (While the existing collection costs of \$30-57/ton could have been reduced to \$10-19/ton, the proposed change to racks was not implemented because the federal labour subsidy was not cut back. The feared loss of labour subsidy had prompted the engineering study.) (8)

B. Single Compartment

In order to overcome the disadvantages of the two previously discussed approaches for newspaper collection, a packer was modified by a truck body manufacturer for use in a Southern California municipal area.

A hole was cut in the upper front bulkhead of a side-loading (Shu-Pak) packer truck and a 3-cu yd. compartment was installed inside. A bucket loader placed behind the vehicle cab raises and dumps collected papers into the compartment.

In contrast to the separate truck approach, the compartment approach allows the simultaneous collection of refuse and newspaper. Also in contrast with the separate truck approach, in which truck space is usually underutilized, the special compartment was designed to fill to capacity with newspaper. In contrast to the low newspaper capacity of the rack approach, the special compartment has more than twice the capacity of a refuse truck equipped with a single rack. Therefore at typical participation rates, the compartment approach does not require expensive off-route unloading into containers or transfer vehicles -- incremental costs associated with the rack approach.

The bucket-compartment system does not reduce the payload capacity of the refuse vehicle and although newspapers tumble through the body of the truck when the truck tips for off-loading, paper is not contaminated. The main expense associated with the design is for off-loading since a below-grade container with ramp access is required for non-manual handling after papers are dumped. Prices in 1976 involved startup costs of \$1,700 per truck modified and \$10,000 for off-loading facilities.

The main drawback of the prototype vehicle is its slow bucket loading time. The bucket holds two average size newspaper bundles. Two bundles can be easily pitched into the bucket but additional bundles have to be carefully placed lest they fall out into the hopper on bucket ascent. If the driver/collector forgets to activate the bucket descent control before dismounting from the cab, or is not compacting refuse while waiting for the bucket to ascend, time-consuming irritations result. To rectify the inefficiencies of loading, future installations are recommended to have an independent hydraulic pump to raise and lower the bucket (instead of an air control valve) with bucket operation controls in both cab and hopper positions. These modifications add \$500 to vehicle startup cost, up from \$1200, but are necessary to reduce loading time. If incremental load time of 0.10 minutes per participating stop could be halved, even a low revenue of \$8/ton would be more than sufficient to cover additional costs.

Assuming technical vehicle changes and proper off-loading facilities, the economics of this compartmentalized vehicle can be compared with the rack and separate truck approaches. An engineering report on the truck design points out that in its overall impact on total waste collection, this vehicle compares more favourably than the rack approach: while loading time is equal,

transfer of paper into secondary containers or vans is unnecessary due to larger capacity, and off-loading time at a central facility is minimal. Compared to separate trucks this special vehicle is more cost-effective when collection frequency is weekly or bi-weekly at participation rates lower than 50%. However, for monthly collections at greater than 50% participation, a separate truck approach becomes more economical. (9)

C. Modified Dump Truck

In Downey, California, co-mingled glass, cans and paper were collected in a small dump truck by a private hauler during a one-year source separation pilot program. The program broke even at 50% participation mainly because no capital costs or depreciation were allocated to source separation. When the program was expanded city-wide to 18,000 homes the hauler needed a larger truck capacity, in order to minimize frequent and costly trips to a dealer in a neighbouring city where recyclables were sorted.

A specialized vehicle was developed by a local truck body manufacturer, starting with a standard cab and chassis, both second-hand. A dual driving control system was installed on the right-hand side of the cab. This permitted easier spotting of curbside set-outs by a driver positioned on the right-hand side of the cab. It also decreased collection time by cutting the number of steps (between cab, set-out, and side-loading body) that would have to be taken by a driver acting as collector (one-man crew).

The truck body was custom designed with an indentation on both sides of the body so that a collector could ride outside the truck close to the side-loading openings. These indentations could be removed for conversion to standard dump truck configurations. With a capacity of 13.5 cu yd., the value of the vehicle was \$15,000 in 1977. For public relations and aesthetic reasons, the truck was painted in bright colours. The commercial hauler expected to make a profit from the source separation program but also considered the program to be valuable public relations. (10)

D. Miscellaneous

When a source separation program is run by a non-profit ecology or volunteer group, the economics or productivity of "make do" vehicles is rarely calculated. These programs do not have existing equipment because they do not have a refuse collection operation, except for the few programs that offer refuse collection along with recyclables pickup for a fee. Equipment is usually donated, leased, or bought second hand. These vehicles are sometimes modified by

raising the sides of pickup trucks, removing seats from school buses, and building compartments into a variety of vehicles. On the other hand, little modification is necessary when conventional trucks are equipped with bins, a more versatile option which can be used for curbside collection, for servicing drop-off bins, or for mobile collection centers (see Section 8). It is interesting to note that a May 1978 California conference on source separation featured a "trade show" for separate collection vehicles, including a rodeo contest for vehicle performance. (11)

7.4.3 Special Combinations of Existing Equipment

This vehicle category consists of trailers and container trains pulled by conventional pickup trucks and refuse vehicles. It is helpful to illustrate the decision-making process related to the choice of a container train in San Luis Obispo, California. In this multi-material source separation program, research costs were paid by grants from higher government levels, but a private hauler was responsible for initial capital and operational costs of the pilot test. Consequently four criteria guided vehicle choice: capital cost; simplicity of operation; compatibility with existing equipment and facilities; and manpower and maintenance requirements. The following options were rejected for reasons stated:

Table 8: Collection Vehicle Options Considered in San Luis Obispo

Options Considered	Reasons for Rejection
- Racks installed on rear-loaders (on front bumper, under chassis, above fenders)	- Decreased maneuverability - Insufficient capacity requiring container drop-off points in residential areas - Expensive modification costs - Available designs for newspaper only
- Side bags on rear-loading trucks (canvas or fishnet material, filled from top and unloaded by pulling drawstring)	- Add too much width to truck
- Long-tongued trailer attached to rear-loader (4'-6' with three compartments)	- Interferes with hydraulic dump attachment used for servicing 1-cu yd bins - Inconvenience to collector
- Scooter with small hydraulically operated trailer which holds one 3-cu yd. bin (2 compartments)	- Under powered - Good only for short haul distances - Limited capacity requires many trips for off-loading or a "mother" vehicle to which scooter acts as satellite - High capital investment (\$10,000-\$20,000)

Table 8 (continued)

Options Considered	Reasons for Rejection
- Flatbed truck with bins on back	- Already available in hauler's equipment pool but hard to off-load and could not be allocated full-time to separate collection
- Standard vehicle modified with built-in compartments	- Would have to be purchased at a prohibitive \$6,000-\$20,000 cost

The equipment chosen was a bin-toting trailer, called a "container train". Designed to be pulled behind a pickup truck, the trailer holds three 3-cu yd. bins, each supported by an individual pair of hydraulic forks. The trailer has a 10 cu yd. capacity. As stock equipment, available from a truck body manufacturer, it cost \$3,500 in 1977. A 10,000-pound capacity ball hitch was installed on a 1/2-ton pickup truck along with some additional wiring. This 1/2-ton pickup was later replaced by a 3/4-ton pickup because of problems caused by excessive weight.

For off-loading the bins, the company did not have a rotating head forklift in its yards. Instead, trapdoors were built into the bins so that cans and glass could be tilted and dumped with a standard forklift into roll-off storage bins. Manual off-loading of newspaper from the bed of the pickup truck was chosen instead of installing a hydraulic dumping tailgate on the pickup truck, since the latter would have involved disconnecting the container train in order to eject newspaper. While newspapers are collected on the truck bed, the three bins on the trailer are used for cans, mixed glass and rejected materials. (12)

A similar approach has been chosen for a Seattle, Washington pilot program. Rejected options included a non-compartmentalized truck/van and satellite collection (a "mother" rear-loading packer which would service two or three small vehicles and also collect recyclables). (13)

The Seattle vehicle is a 1/2 ton flat bed truck, containing 6 2-cu yd. bins. The sides of the truck have hinged trap doors through which collectors load bags of glass, bags of metal, and bundles of newspaper. An auxiliary trailer, which holds another 6 bins, is used only on routes with high participation. Bins are off-loaded from the truck bed and trailer by forklift at a handling station where the contents of bags are sorted and processed. (14)

Another vehicle combination in wide use on the U.S. west coast is the trailer-toting scooter or very small pickup truck. These have been adopted for energy efficiency reasons by small companies modeled on the ORE Plan. In these systems source separated recyclables are collected with or without normal refuse for a monthly fee. The small vehicles are satellites to a larger truck parked in the neighbourhood. Several models of scooters, resembling golf carts, are available including the "Cushman" and "Alsport UT-10". These haul standard open trailers filled with drums or single bin-toting trailers. (15) As the low-powered, short haul scooters and pickups are not feasible for Ontario winter weather conditions, they are not discussed further. The concept of satellite vehicles, working from larger trucks or intermediate handling sites, still merits consideration for the Ontario situation.

7.4.4 Specially Designed New Equipment

A. Compartmentalized Source Separation Vehicle

Under a federal demonstration grant, compartmentalized vehicles were tested in multi-material source separation programs in the northeastern U.S. communities of Somerville and Marblehead. The purpose of the test was to determine levels of productivity (homes per hour and tons per hour) for compartmentalized vehicles which can collect several recyclable fractions concurrently. This is in contrast to the use of an undivided vehicle which repeats routes in collecting each recyclable fraction separately (multiple pass system). The latter requires more labour and equipment time and more vehicle miles but can use standard packer and open vehicles.

Considerations related to truck design for the Somerville and Marblehead programs are represented below in point form. The trucks are non-packers. Because recyclables are more dense than refuse, compacting is not necessary to increase the payload of a source separation truck. These special trucks were chosen over smaller pickup trucks which are limited in weight and volume capacity. Another rejected option was the installation of compartments into large open trucks. Such trucks require three-man crews and have loading heights that inhibit efficiency.

Table 9: Truck Design Considerations and Choices in Somerville and Marblehead

Considerations	Somerville	Marblehead
Number of trucks needed based on original estimates	Two (later supplemented by an open partitioned dump truck)	Two
Total capacity	20 cu yd. (3-4 tons) per truck	18.8 cu yd. (3-4 tons) per truck

Consideration	Somerville	Marblehead
Basic design	Standard truck chassis	Standard truck chassis but shorter trucks because of narrow streets and tight corners
	Cab mounted behind engine	Cab mounted over engine
1977 purchase price estimates	\$25,000-\$30,000 each	\$25,000-\$28,000 each
Number of compartments in truck	Compartments created by moveable aluminum partitions in truck body	
	Two: paper and glass-cans	Three: paper, flint glass-cans, and coloured glass-cans
Compartment capacity	10 cu yd.: 10 cu yd. respectively (50:50 ratio instead of original 70:30)	9.4 cu yd.: 3.2 cu yd.: 6.2 cu yd. respectively (50:17:33 ratio as originally envisioned)
Loading	Compartmentalized, hydraulically operated rear bucket lifts and unloads materials in 30 seconds into body; bucket level loading position and angle determined manually	
Bucket capacities	0.9 cu yd. and 0.9 cu yd. respectively, total of 1.8 cu yd.	.85 cu yd., .30 cu yd., and .60 cu yd. respectively, total of 1.75 cu yd.
Unloading	Body is hydraulically tipped and materials fall through rear doors, opened in sequence to dump each material	
	Materials dumped on floor of transfer station --4 minute total	Vehicle weighed at buyer sites as each of three compartments unloaded--8 minute total
Prototype problems	<ul style="list-style-type: none"> - As bucket rises and tips to load recyclables into body, excessive clearance between bucket and partition walls causes materials to fall into wrong compartment or onto ground - Bucket pivot point causes partitioned truck body compartments to fill unevenly (heap in middle) 	

	<ul style="list-style-type: none"> - As truck body tips to unload, bucket sometimes strikes ground - Bucket bounces during travel - Bucket rises too high during loading (15') - Bucket extends too far behind truck during travel and sometimes obscures rear truck lights during loading - Rear door hinge failure due to stress of shifting materials during unloading and open doors striking ground during unloading - Failure of rear axle wheel bolts due to rocking vehicle in order to off-load materials
Modifications made	Bucket walls and partitions in bodies increased to avoid spillage
Modifications recommended	<ul style="list-style-type: none"> - Change in bucket pivot points to permit bucket loading into extreme front and rear of body - A means to secure bucket during travel - Safer crew riding positions rather than on small step on bucket - Eliminate horizontal plate at front of body so that materials can be loaded into front of body; replace with vertical shield to prevent materials from being thrown onto cab roof - Shorten distance to which the bucket extends beyond the end of the body - Reposition rear lights by adding lights to buckets and to top of rear doors - Strengthen rear axle wheel bolts to withstand stress of rocking when unloading OR design body to tip at a higher angle - Redesign rear doors so that they do not strike ground during unloading, and strengthen hinges - More partition adjustment flexibility (more notches cut into rack which holds partitions)
Reasons for successful evaluation	<ul style="list-style-type: none"> - Greater efficiency of collection than other vehicles - Loading time adequate (30 seconds per bucket; 15-30 buckets per load) - Low maintenance and capital costs (less expensive than packer truck but more expensive than open truck) - Adequate capacities (19-20 cu yd.; 3-4 tons) - Efficient unloading (2-3 minutes per material) (16)

B. Combined Refuse-Source Separate Collection Vehicle

Designed to collect refuse and recyclables together, a prototype vehicle, called the "Separated Discards Carrier" (SDC), combines the features of several categories discussed above. It is a rear-loading packer truck, fitted with side racks for newspaper and has side-mounted buckets for loading glass and metal into compartments. Consequently it is a hybrid of the compartmentalized truck tested in Somerville and Marblehead and a rack-fitted packer. The SDC was designed and developed jointly by a U.S. non-profit ecology research group and a truck body manufacturer. The special truck is billed as ideal for private and municipal haulers where there is legislative and public demand for source separation. SDC characteristics are outlined below. (17)

Table 10: Design Characteristics of the Separated Discards Carrier

Refuse capacity	<ul style="list-style-type: none"> - 15 cu yd., 3.75 ton - Rear-loading, continuous-feed (auger-fed) packer
Newspaper	<ul style="list-style-type: none"> - 42 cu ft. (1.56 cu yd.), 840 pound capacity - Enclosed shelves with hinged doors - Whole compartment lifts off for replacement with an empty rack - Note: this capacity appears to be inadequate based on complaints with conventional rack-fitted packers (see 7.4.2 A and B)
Cans & glass	<ul style="list-style-type: none"> - Two 4-cu yd. bins mounted between cab and packer body; 2124 pound glass capacity; 590 pound metal capacity - Full bins rolled off at delivery site and replaced with empty bins - Two loading buckets (with hinged safety lids to prevent wind-littering) mechanically lift materials up sides of truck and tip into bins - Bucket capacity is 5.6 cu ft. with a 90 second lift-dump-return cycle
Total vehicle capacity	5.5 tons
Tare	20,000 pounds (empty truck weight)
Labour requirement	One- or two-person crew
Off-load time	5 minutes total for refuse and recyclables

This vehicle appears to have a limited capacity for newspaper. In contrast to the Marblehead-Somerville trucks, can and glass bin size cannot be adjusted, which may be necessary depending on local recyclables composition. The 1½ minute bucket cycle is lengthy.

After a short period of testing in a small Massachusetts city, designers removed shelves from the newspaper racks to eliminate dead space between stacked bundles. Designers report some problems in bucket loading and tripping mechanisms. They have also added baffles to the inside of glass bins to reduce breakage of whole bottles. (As colour mixed glass is collected, but colour separation is specified by the glass buyer, glass containers must be colour sorted at a handling facility.) (18)

The significance of the SDC is indicated by its dual purpose. This concept eliminates the double fuel and labour costs of non-simultaneous refuse and recyclables collection trips in multi-material source separation programs sponsored by municipal and commercial refuse haulers. The SDC approach goes even further than the rack and compartment approaches (7.4.2 A and B) in institutionalizing multi-material source separation as a waste management option.

(See Exhibit 1, appended to this section, for illustrations of selected source separate collection vehicles.)

7.5 Summary and Conclusions

Although vehicles are employed at several stages of the material flow (collection, handling, hauling to market) in source separation programs, this section concentrates on vehicles employed in curbside collection. Sponsors of source separation programs agree that collection efficiency is key to program economics. In significant programs, vehicle choices are made with a view to efficient loading and off-loading of materials.

Vehicles currently employed in source separate collection include unmodified standard trucks; modified trucks (modifications include the addition of racks, the construction of a single bucket-loaded compartment, and the placement of rider/collector indentations on a side-loading packer); special combinations of trucks and trailers (most notably, bin-toting container trains hauled by pickup trucks, scooters, and flatbed trucks); and specially designed new equipment such as compartmentalized bucket-loading trucks for two or three categories of recyclables (the design is based on that of a bucket-loading rendering vehicle) and the "Separated Discards Carrier" with bucket-loading compartments for glass and cans, racks for newspaper, and a refuse packing body.

Characteristic of the advancing state of the art and of the more recent concern over multi-material collection efficiency, a number of engineering studies have been carried out to determine the appropriate truck for a given program or to determine the circumstances under which one vehicle type is more efficient than another. These engineering studies are summarized in this section.

Despite the attempts at adapting, combining, and re-designing collection equipment in other jurisdictions, there are no known, mass produced or "bug free" special vehicles in use at the present time. This lack of a standard, tested vehicle is not seen as a critical problem by program sponsors because site-specific considerations form the bases for choices of appropriate vehicles; that is, curbside collection vehicle designs are chosen according to parameters defined by other source separation program variables such as the following:

- Number and kind of fractions collected
- Material preparation requirements of buyer and/or the program's resources for processing
- Distance from collection route to central program handling site or buyer site
- Quantities collected as determined by local materials generation, composition, and recovery, participation, collection area size, and frequency of collection
- Financial resources as determined by fees, revenues, disposal credits, subsidies, demonstration grants, and methods of cost allocation
- Stage in program life cycle from pilot to full scale operation
- Type of program sponsorship: municipal, commercial, third sector
- Integration of recyclable and refuse collections
- Single or multiple pass collection approach
- Community and geographic characteristics: weather, terrain, housing density
- Compatibility with off-loading facilities at central program handling site or buyer site
- Compatibility with labour requirements and existing equipment pools.

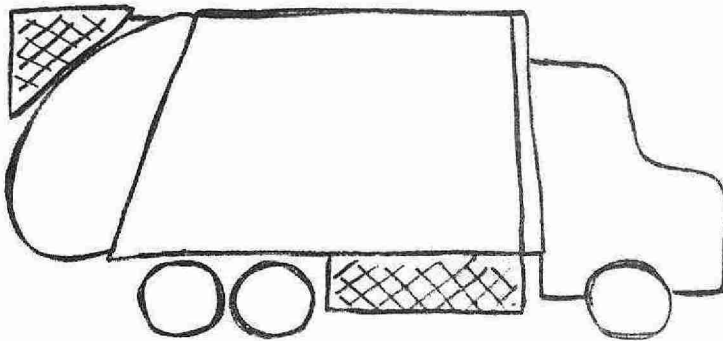
Applying advances in the state of the art elsewhere to the situation in Ontario, several conclusions can be drawn:

- Planners of programs should be encouraged to take a businesslike approach to choice of vehicle options. The vehicle choice should be rationalized according to other program design requirements as listed above.
- The three most innovative, yet relevant, vehicle concepts identified in this assessment could be tested in existing or future Ontario source separation programs. These three concepts are: the compartmentalized truck,

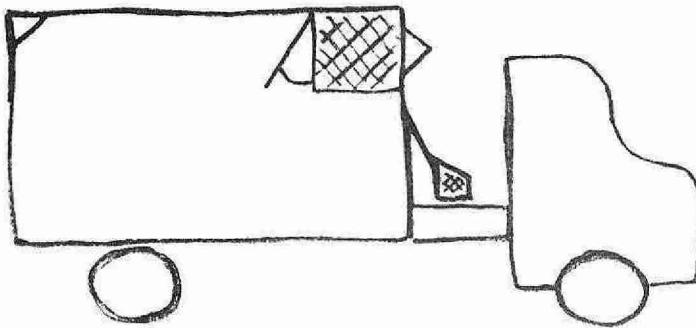
the container train, and the integrated refuse-recyclables carrier. Capital equipment cost would likely require government subsidy. One such initiative is underway in Toronto where a federal subsidy is enabling two companies (a source separation program and a truck body manufacturer) to jointly develop a multi-material source separation vehicle suitable for small Ontario municipalities. Test results, when available for this vehicle, should be examined by the Ontario government.

- In addition to technical vehicle design, experience elsewhere indicates that collection efficiency is also affected by other considerations such as crew size (i.e. one- or two-person crews are less costly); loading methods (e.g. pitching is faster than stacking); worker familiarity with and acceptance of equipment (e.g. trailers are not popular among collectors); route design (e.g. all right-hand turns reduce travel time); collection day (i.e. recyclables collection on a non-refuse collection day eliminates collector confusion as to what is set out in containers); and so forth. It would be useful if these and other streamlining cues were compiled and made available to Ontario program planners and operators.

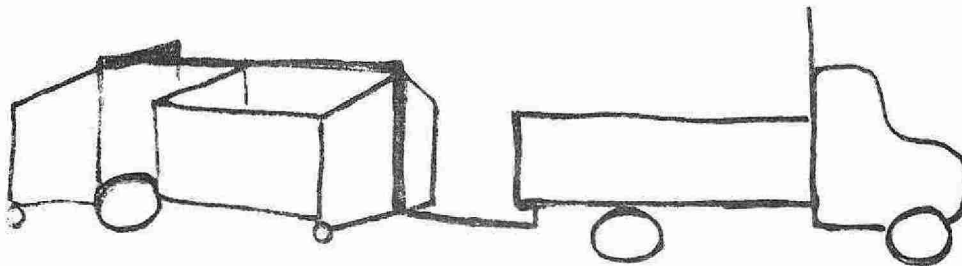
Exhibit 1: Illustrations of Six Source Separate Collection Vehicles



Side and Overhead Racks (indicated by meshed lines) on Rear-Loading Packer Truck (employed in many localities; see 7.4.2.A in text)

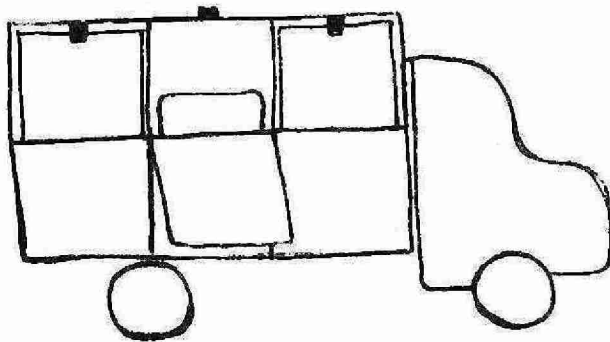


Bucket-Loaded Single Compartment (indicated by meshed lines) in Side-Loading Packer Truck (employed in Palos Verdes Peninsula, California; see 7.4.2.B in text)

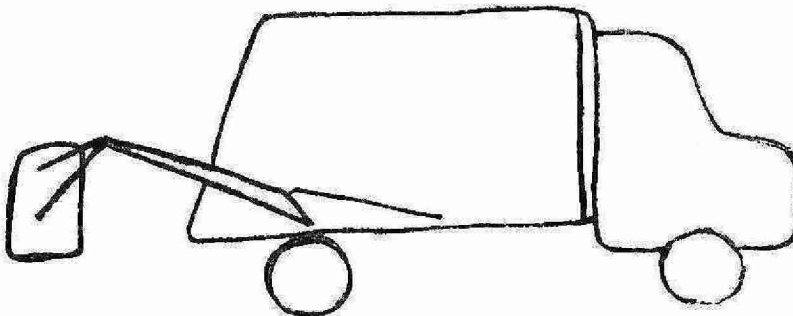


Container Train Drawn by Pickup Truck (employed in San Luis Obispo, California; see 7.4.3. in text)

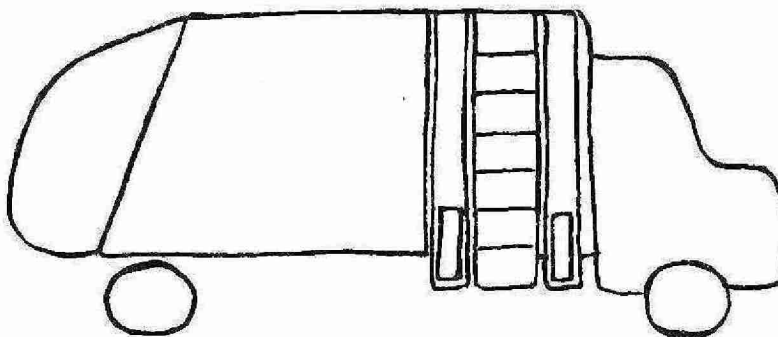
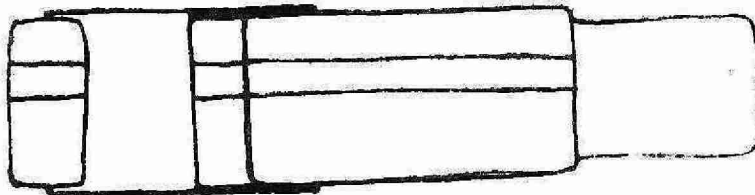
Exhibit 1 (continued)



Enclosed Flatbed
Truck with Bins
(employed in
Seattle, Washington;
see 7.4.3 in text)



Bucket-Loading Com-
partmentalized Truck,
Side and Top Views
(employed in
Marblehead,
Massachusetts; see
7.4.4.A in text)



"Separated Discards
Carrier." Behind Cab,
Right to Left: Cans
Bucket Lift and
Storage, Newspaper
Racks, Glass Bucket
Lift and Storage, Packer
Body, Compactor
(piloted in Exeter,
New Hampshire; see
7.4.4.B in text)

SECTION 8

SOURCE SEPARATION SYSTEM DESIGNS FOR RURAL AREAS:
TOWARD REGIONALIZATION8.1 Introduction

The feasibility of rural source separation is inhibited by the joint problem of low recyclable throughput and the expense of hauling collected materials to distant market points. There appear to be two pre-conditions for rural reclamation in the U.S. These are, the presence of active local groups and/or pressure from higher levels of government to bar unsound disposal practices. Both conditions affect the relatively high costs of rural source separation. Volunteer and non-profit programs are characteristically low in cost (free labour, donated equipment and services) so that revenues after hauling do not have to be high to off-set other costs. Where rural areas have no disposal option, or are faced with expensive transfer and regional landfill, revenues after hauling do not have to be high for source separation to compete with alternatives.

Several kinds of rural source separation systems and designs exist in the U.S. Their spokespersons are deluged with information requests as more rural areas are looking at source separation. Recent legislation in the U.S., which mandates the filing of waste management plans by lower levels of government, is likely to spur more source separation activity in rural areas. Mechanical resource recovery options are unsuitable for low garbage throughput and limited finances in rural areas. This section will examine three rural prototypes and add a fourth system presently used in an urban area but applicable to low population density situations. The aggregate of the four has implications for an Ontario regional source separation network. Regionalization, with its economies of scale, can help to overcome the rural low throughput-expensive haul problem by reducing costs in relation to revenues.

The following program designs will be examined in this section.

8.2 Mobile Drop-Off Systems

- A. Arcata Community Recycling Center
- B. Project Arrowhead

8.3 Collection Centres

- A. Nottingham and Twenty-One Offspring
- B. Lincoln County, Maine

8.4 Door-to-Door Rural Collection
The Vershire Plan8.5 Processing Centres Fed by Satellites
Hypothetical Connecticut Plan

8.2 Mobile Drop-Off Systems

- A. Arcata Community Recycling Center (ACRC): (1,2)
 Serving a town of 10,000 and its surrounding area, ACRC has evolved into a non-profit business since its early ecological days. Emphasis is on education, self-sufficiency, the generation of local business opportunities, and efficient operations. Capital grants over the last seven years have amounted to \$53,000 and various categories of subsidized labour include probationers, senior citizens, volunteers and student field work placements. Recovered amounts of glass, metal, paper and several other fractions, average 90 tons per month. A monthly revenue of approximately \$1700 per month results after hauling costs which are considerable. Revenues pay for all operating costs and several salaries. The community is made up of university staff and students, and ex-city dwellers from mid-state. This is thought to be an important socioeconomic factor for high participation in addition to ACRC's media and school education work. An estimated 16% diversion of local solid waste is attributed to ACRC's program.

Sources of recyclables are as follows:

1. An independent substation is situated in a town seventy miles south of Arcata. It recovers twenty tons per month of material in its location at a county dumpsite where residents have always brought garbage. Supervised by an on-site recycling manager paid by a federal subsidy, the substation is funded by a county grant. The substation co-ordinates with ACRC for joint shipping and sales of materials as well as publicity and technical assistance.
2. A mobile recycling unit visits four outlying villages once per month each, on Saturdays. The mobile unit is a flatbed truck with a hydraulic tailgate adaptable to other uses. The cost-effectiveness of this operation has not been determined by ACRC. It was financed by the same grant as the substation with the stipulation that the grant money be used for non-town recycling activity. The mobile unit parks from 10:00 a.m. to 2:00 p.m. at focal points such as a grocery store, post office or school. Large turnouts of participants are assisted in sorting by the driver. These truck depots obviate the need for site rental and trash removal (characteristic of unattended bins). Three to five tons of materials are recovered per stop. ACRC's goal is to develop a much wider mobile network.
3. A residential curbside pilot program is slated but not yet implemented. It will be carried out inside the town under a joint agreement with a local refuse hauler, who has a contract in Arcata.
4. A free business collection program serves over sixty businesses in Arcata and a neighbouring town of 30,000. Apartments, bars, restaurants, stores

and offices are provided with bins and barrels for glass, cans and various paper grades. The double purpose of public relations and reclamation characterizes this operation.

5. Drop-off bins are placed in two self-serve locations in town.

6. Civic clubs carrying out drives are paid for each ton of newspaper.

Processing and transport are done on a strict business-like basis. As the only local market is an eight-mile distant aluminum (uncrushed) buyer, volume reduction is essential in Arcata. All paper and tin cans are compacted and baled for a 140-270-mile trip to market, and hauled by a local trucker. Unsorted glass is crushed in a machine invented by a local resident and stored in 20-yard containers provided by the buyer/hauler for the 200-mile trip to market by truck (it was previously rail-hauled). Some green wine bottles are bought by a bottle washer for resale to wineries. The equipment pool consists of a baler-compactor, three glass crushers, forklift and three various sized trucks. No sorting or upgrading activities are performed. Reclaimed motor oil is stored in a holding tank and in drums until markets can be identified. A reuse store, where standard-top jars and wine bottles are sold, is also operated.

The significance of ACRC is its location in a small town with mobile service for scattered rural surrounding areas. Secondly, by consulting with local merchants, ACRC has applied basic business principles to the preparation and shipment of materials to distant markets. Nevertheless the program is heavily subsidized by capital, demonstration, education and job-creation grants. While spokespersons suspect that drop-off and mobile operations could be self-sufficient, there is no hard cost data to back up this claim. (Arcata is in northern California.)

B. Project Arrowhead:(3)

Operating in Duluth, Minnesota, this is a non-profit sheltered workshop agency that has operated a source separation drop-off program for four years in an urban area of 130,000 people. As the initial operation became self-sufficient, the program was recently expanded to encompass a 25,000 square mile area--a radius of 150 miles in three directions from Duluth. Arrowhead staff point out that a rural program alone does not generate enough revenues to cover costs unless it is pinned to an urban operation. The rural component, now operated at a loss, is continuing with the faith that economics will improve.

Arrowhead's emphasis is on worker training. A 1974 capital grant of \$36,000 funded the startup of the labour-intensive reclamation scheme. Permanent staff of the social agency co-ordinate several federally funded CETA workers and forty-three handicapped sorters. Within a quarter million dollar budget, 30% is offset by recyclables revenues of \$70,000-\$78,000 per year. Diversion of solid waste in urban Duluth is estimated to be 4%-5%, but no figures are available for the impact of Arrowhead's rural activity.

Sources of recyclables are as follows:

1. Urban operations include servicing residential drop-off points and picking up at commercial and office locations for three colours of glass, three categories of metal and several grades of paper including confidential records (a shredding service for a fee and resale, for a double profit).
2. Rural operations involve driving semi-trailers to outlying areas. The trailers are left behind as collection buildings and are equipped with 55-gallon drums. Trailers are unmanned, open twenty-four hours a day and have wooden steps for access. The front one-third of the trailers is designated for bagged and bundled newspaper and corrugated cardboard, while barrels for mixed cans and colour mixed glass line both sides. Arrowhead is presently designing wire mesh square bins set on wheels to replace the round barrels which are difficult to off-load and which waste space in the trailers. The cab that hauls away a full trailer, leaves behind another empty one.

Processing and transport are extremely labour-intensive in keeping with Arrowhead's rehabilitative goal. Neither cost-effective, nor more mechanized processing, is a priority. Markets are strong in this area and close by; consequently upgrading, as well as volume reduction, is emphasized. Glass is colour sorted, denuded of metal rings and plastic jackets, then crushed before shipment in a forty-foot semi-trailer. Reference has already been made (see Section 6) to Arrowhead's acquisition of ferrous rejects from an aluminum can plant on the return trip from delivering glass. Ferrous is combined with other collected metals and hand sorted on a conveyor. Aluminum is not processed further but bi-metal cans are shredded and all-steel cans are flattened and marketed locally. Three categories of paper are baled and sold: corrugated, newsprint mixed with shredded confidential office ledger, and low grade paper (magazine, kraft bags, junk mail and food boxes).

The significance of Project Arrowhead is its mobile rural collection service for permanently located (trailer) drop-off points. Arrowhead's absence of cost data and the luxury of subsidized labour, make

financial feasibility assessments impossible. In neither Arcata, nor Duluth, is processing done at mobile sites. Instead, material is hauled back to a central site for volume reduction in both, and upgrading in one case.

8.3 Collection Centres

A. Nottingham and Twenty-One Offspring:

Since the implementation of the "Nottingham System" of combined reclamation/incineration, twenty-one other rural communities in New Hampshire have created town collection centres for source separated recyclables and refuse, delivered by individuals and commercial haulers.

The appeal of the system in each case is directly attributable to the prohibition of illegal but cheap burning dumps. Recyclable materials revenue is not viewed as the main factor determining system viability. Recyclables are separated from refuse to cut pyrolytic incineration, transfer or regional landfill costs, that is, to lessen the disposal burden, particularly in the case of the towns which combine reclamation with incineration.

Each of the twenty-one(4) towns (and six others still on the drawing boards) has modified the Nottingham prototype for local circumstances. Several either collect recyclables at shared sites or co-dispose. Variations occur in markets, revenues, use of intermediate processors, amount of on-site processing, hauling, legal obligations for mandatory source separation, hours of operation, fractions collected/sold, equipment, method of refuse disposal, population size served, capital requirements and operating and maintenance costs. Regarding costs, all budgets include disposal of refuse residual because reclamation and disposal are jointly part of the total waste management system, i.e. consequently there are no data for the incremental costs of reclamation. The only common element to each is the delivery of source separated materials to collection centres. Extrapolated data about five systems(5) are outlined in Table 11 which highlights certain salient characteristics.

Table 11: Comparison of Five Selected Nottingham-Type Systems

Characteristic	Nottingham	University of New Hampshire serving 7 towns	Swansey	Plymouth	Meredith
Population	1200, doubles in summer	10,000 at University; 34,458 in towns	4900, additional 1500 in summer	3200	3800, additional 9000 in summer
Startup	January, 1974	October, 1974 at University, towns joined between 1974 and 1977	1975	June 1975	January 1977; neighbouring town of Center Harbour joined April 1977 with population of 654
Plant	30' x 60' wood	105' x 50' steel clad	35' x 80' prefab steel (transfer site of recyclables and landfill-bound refuse)	50' x 100' cement block	40' x 70' prefab steel
Impetus	no disposal site, town voted support and money	University started as educational and demonstration project; towns joined because could reclaim with no capital costs	local ecology group	had to close dump, town voted support	need to close dump
Legal	mandatory for householders and haulers, otherwise penalty	must be delivered separated at University but towns differ: glass mandatory in 2; newspaper mandatory in 3; cans mandatory in 2--for householders and haulers	voluntary, voted against mandatory	mandatory since 1976 for householders and haulers, otherwise penalty	mandatory for glass only at onset, rest of fractions mandatory in July '77 for householders and haulers

Table 11 (continued)

Characteristic	Nottingham	University of New Hampshire serving 7 towns	Swansey	Plymouth	Meredith
Fractions and Quantities (Yearly Average in tons)	1974-1976: news - 13.9 glass - 61.5 cans - 16.8 refuse large appliances	glass: clear, brown, green and cans - 137 news - 270 fine - 32 corrugated - 148 mixed - 117	quantities not available: news mixed paper, corrugated; clear, brown, green glass; cans and scrap metal; tires; brush	glass: flint and green/brown - 338 cans - 91 news - 78 corrugated - 156 trash, appliances	quantities not known yet: tires, cans, news, corrugated, scrap metal, 3 colours of glass
Disposal Method and Alternatives	incineration: illegal dump cost \$3,023, vs. landfill cost \$17,740, vs. regional landfill shared cost portion \$15,530	Towns vary: incineration, transfer, landfill; savings not quantified: 2 towns say no savings, 5 towns guess some savings, 1 town incurs extra costs for curbside pickup	transfer for disposal elsewhere; no landfill possible in town; reclamation saves cost/load to haul to landfill and landfill fee, but not quantified	incineration; old dump illegal, would cost \$12,000/year	incineration; old dump illegal, would cost \$16,000/year; no sanitary landfill site possible
Manpower	2 men work 2 days/week (safety laws prescribe 2 men=surplus labour); volunteer administrator	five 8-hour days with manager, 1 full-time worker and part-time work-study students; administered by University	one worker/manager with one part-time helper work three 10-hour days/week; administered by town roads department (not allocated to reclamation)	one worker/manager and two other workers put in five 8-hour days and one 4-hour day	seven 7-hour days/week put in by two to four men, less in winter

Table 11 (continued)

Characteristic	Nottingham	University of New Hampshire serving 7 towns	Swansey	Plymouth	Meredith
Streamlining and Changes	better glass price; changed to pyrolytic incineration; building adapted for easier storage and loading of market-bound goods; newspaper and corrugated abandoned when market slumped	evolved from University pilot from paper to multi-material serving other towns which joined at different times; increased throughout and better prices in 1977; glass crushing discontinued because of large volume truck pickups; can baling discontinued because made baler too dirty but can flattening started in order to get better price; temporary mixing of glass and cans discontinued to boost price; contamination problems show need for more education in towns	glass crushing discontinued because of large volume truck pickups; some difficulty in marketing unflattened cans	mandatory change saves fuel and maintenance on incinerator; glass crushing discontinued because of large container shipments; considering full colour sorting to get better price; problems in can crushing with large metal objects	changed to mandatory because high maintenance, fuel and downtime of incinerator associated with molten cans and glass; corrugated used to be burned, now reclaimed therefore baler added; storage facility changes made; plan more processing in order to eliminate household burden of separation

Table 11 (continued)

Characteristic	Nottingham	University of New Hampshire serving 7 towns	Swansey	Plymouth	Meredith
Processing	hand baler frame for news; glass: colour sorted, contaminants removed, crushed; cans: magnetic separation of ferrous from aluminum, contaminant removal, mechanically crushed; reuse area, white goods pile, incineration of residue	once delivered to University: tab cards direct to shipping container; floor pit baler for all paper; pre-sorted glass not crushed or upgraded; cans flattened with highway roller	none for glass and cans; 3 categories of paper baled in floor-mounted baler	glass not crushed; cans crushed; 2 categories of paper baled in floor-mounted baler	none for cans or glass; (no market for cans at time of writing); corrugated baled in floor-mounted baler
Hauling to Market	responsibility of town to haul to various markets in 3 states; flatbed stake truck	University packer trucks pick up bulk-lift containers in five towns (6 driver hours per day at no cost to towns); all material picked up by buyers from U.	cans and glass picked up by intermediate processor; paper picked up by dealers from two States	intermediate processor provides bins and picks up cans and glass; commercial hauler takes paper to market @ \$6/ton ship charge	high school alumni association collects news; intermediate processor provides bins and picks up glass; scrap metal, tires and corrugated picked up by buyers

Table 11 (continued)

Character- istic	Nottingham	University of New Hampshire serving 7 towns	Swansey	Plymouth	Meredith
Annual Cost- Revenue	gross operating:\$10,302 revenue: \$ 2,517 net operating:\$ 7,785	FY 1976 and 1977 average plant: \$23,409 collection: \$28,629 revenue* : \$18,765 net operating : \$ 9,864 (*hope that 1978 revenues will exceed costs and be dis- tributed back to towns)	gross operating: \$31,459 revenue : \$ 2,659 net operating: \$28,000	1976 gross operating: \$34,362 revenue = sales \$ 7,929 +penalties:\$ 2,225 net operating:::\$24,208	estimate for 1977 gross operating: \$42,241 revenue: \$ 1,512 net operating: \$40,729 (revenue does not include corrugated) revenue expected to be higher with mandatory separ- ation
Capital Costs	equivalent to \$76,300 but all subsidized by grant donations; no debt	plant and equipment paid by University \$80,405; truck cost not allocated (\$50,913)	no debt for site and only oppor- tunity costs for equipment (\$39,669)	loans repayable at \$40,000/year for 10 years (total \$296,000)	loans repayable at \$27,500/year for 20 years (total \$215,241)

It can be seen from the Table that the systems started up between 1974 and 1977 and serve towns with permanent populations ranging from 650 to 4900 inhabitants. Reclamation is combined with incineration, transfer and landfill. Mandatory separation is associated with the towns that incinerate residues. Several voluntary systems have been or will be changed to mandatory separation in order to reduce the impact of molten glass and metal on the pyrolytic incinerators. Others have undertaken separation of additional recyclables in order to cut fuel and time for incineration. Collected fractions differ widely. Nottingham is the only town that hauls its recyclables to markets. All others are served by buyers and intermediate processors. Capital outlays vary from zero to just under \$300,000 and annual net operating costs range from \$8000 to a high of over \$40,000.

On-site handling of recyclables always involves routing of delivered materials into larger storage containers, and baling of paper, but upgrading is limited to visual inspections (quality control) especially for hard metal objects which would damage can crushers where used in three locations. Contrary to expectations, glass is volume reduced in only one system because large loads of glass are picked up by purchasers--loads which would exceed rural road limits if glass were crushed. Over time, various changes have been made in these systems: improved incineration machinery, rebuilt storage and loading facilities, and decreased or increased volume reduction in order to meet market specifications and acquire better prices for materials.

It is important to restate that the motivational impetus for all reclamation facilities (except the one with refuse transfer to a regional landfill site, stimulated by an ecology group) is the loss of cheap but illegal landfill options. Increased reclamation and mandatory separation are geared to increasing the technical and economical performance of the systems, and not done out of ecological concern, although increased community pride is reported for all systems. The latest Nottingham proposal, if voted into existence, will also mandate the separation of food and yard waste in order to improve the efficiency of incineration.(6) System streamlining continues in these programs and revolves around the linkage between 1) participation as a function of household preparation, 2) cost of processing, 3) hauling economics, and 4) market specifications--a set of interlocking decisions and trade-offs.

Comment:

Implicit in the preceding Table are several drawbacks of the Nottingham System, when implemented individually:

- Lack of economies of scale in processing (low throughput) and therefore higher operating costs per ton
- Duplication of sites and equipment, therefore high initial capital cost
- Excess capacity in low population areas including over-employment of labour (safety regulations require two staff when plants in operation) and under-utilization of machinery
- Limited bargaining power due to decentralized marketing and therefore, to some extent, lower prices per ton

On the other hand, more centralization would increase the time, inconvenience and fuel expended in the delivery of refuse and recyclables to more distant centres by local residents, by town sanitation departments, and by private haulers. For instance, the most recent adaptation of the Nottingham System is under-going discussion in six New Hampshire towns which must decide whether to trade longer delivery distances for lower per capita reclamation/incineration costs: \$6.30 per capita if four towns participate, from \$3.32 to \$5.08 for five towns, and a low of \$2.53 if all six towns participate. Ten-year commitments required from towns would include proportionate distribution of costs and profits.(7)

B. Lincoln County, Maine:

The manner in which Lincoln County, Maine tried to modify the Nottingham System for regional use entailed a painstaking community planning exercise. Deadlines for closing illegal dumps in 18 towns spawned the formation of a task force that rejected mechanical resource recovery and curbside collection systems outright. The task force examined several disposal alternatives including a reclamation/incineration system based on source separation. While the latter was ultimately rejected on the basis of costs, an outline of the proposed design is illustrative.

The design began with estimates of waste generation and composition for the permanent and resort populations of 18 towns. Seven categories of recyclables and incinerator materials amounted to an expected 21,500 tons per year from residential, industrial, commercial and institutional sources. A thorough market search yielded current materials price data under three different conditions: 1) gross price offered at the buyer's door, 2) price obtainable by delivery to market including transportation costs, 3) price picked up. Glass and cans were found to net more revenue when delivered than when picked up.

This difference in price was high enough to justify the purchase of a truck and bulk container but the estimated impact of beverage container legislation caused planners to recommend the pickup of all recyclables.

Processing was to involve colour sorting but not crushing of glass by plant attendants, magnetic separation and crushing of ferrous and non-ferrous cans, baling of newspaper and corrugated, and incineration of remaining wastes. Labour and equipment requirements as well as capital and operating costs were estimated for five types of plants differing in their capacity (plant size, number of balers, crushers and incinerators) to serve the 18 towns. The cost of operating 13 individual plants was contrasted with differing levels of regionalization. As the level of regionalization increased (13 plants, 4, 3, 2, 1 plants), the cost per ton was shown to be lower due to strict economies of scale, less duplication of equipment, and better utilization of manpower. For instance the net cost per ton of recyclables handling and residue incineration ranged from \$28.70 for 13 plants to \$9.50 for one regional plant. In order to strike a compromise between lowest cost and excessive delivery expenditures (time, inconvenience, fuel), the four-plant option was recommended for a net cost per ton of \$16.00. Ideal regional plant sites were proposed on the basis of fewest annual ton-miles.(7)

Contrasted with the above description, which was rejected by Lincoln County's task force, an alternative was voted on in the spring of 1978. Designed by an engineering firm, the system calls for three components:

- Placement of large rear-loading containers at each town disposal site (53 containers at a cost of \$25,809 with 12 site preparations at a cost of \$1200)
- A collection vehicle to service the containers; a conventional rear-loading packer with a 20-cubic yard capacity)
- Central baling facility for paper (\$15,000)

Containers placed at local landfill sites will be designated for the following fractions (market prices in parentheses, loose and baled respectively): newspaper (\$55, \$70); mixed paper (\$10, \$25); corrugated (\$20, \$43.50) and glass (\$20). Cans will not be collected due to absence of markets within affordable hauling distances. The only household preparation requirement is the removal of metal caps and rings from colour mixed glass. Papers need not be bundled. Residents and commercial/industrial/institutional proprietors disposing at the landfill are asked to voluntarily use the special reclamation

bins. A 20% participation rate is expected. A collection vehicle will move paper to the baling facility, but will transport uncrushed glass directly to market. Only one employee will be needed for pickups, baling and delivery to market. Net profits of from \$10,000 for 20% participation to \$35,000 at 100% participation are claimed possible based on generation estimates.

The decision to bale paper is based on revenue differentials. Without baling, annual costs would be \$6900 less for equipment operation, but with baling, annual operating costs would be reduced by an additional revenue of \$15,000 accruing to baled rather than loose paper. Overall, the baling operation results in a net annual profit of \$8298 instead of a loss of \$370. Documented annual operating costs and net revenue estimates do not include amortized capital costs, but extrapolating from data indicates that with straight line amortization at 6.5% interest over five years, a total cost of just over \$27,000 would be incurred annually if fully allocated, resulting in a total annual per capita cost of less than \$1.00.(8)

While the two proposals outlined above for Lincoln County are difficult to compare because of differences in cost accounting, it is clear that the second system is more economical than the first. The elegant reclamation/incineration design for four collection centres incurs much higher manpower, site and processing equipment costs. This is compared to the simple truck pickup of materials at local sites with direct delivery of glass to market and simple central baling of paper. Annual per capita costs may differ by as much as \$16.00. Because the more economical system leaves substantial amounts for disposal, more landfill capacity is necessary for non-recyclable residuals and the recyclables of 80% non-participants. This is contrasted with the small amounts of inert ash requiring land disposal in the more expensive system.

8.4 Door-to-Door Rural Collection

Source separation programs in rural areas are usually volunteer-run collection centres located in small towns, or bins placed at landfill sites by local government for the collection of recyclables from outlying areas. One house-to-house rural multi-material collection program called the Vershire Plan, was found in two New England towns. Paying subscribers can choose between conventional refuse removal, or refuse and recyclables pickup, or recyclables removal only. For this service a monthly fee of \$2.00 is charged.

Whereas collections began with three-wheeled partitioned trucks, a change was made to more durable pickup trucks. Truck-collected materials are deposited into bulk-lift containers which also function as unmanned drop-off points for non-subscribers in town. These containers are emptied into packer trucks which perform volume reduction on cans and glass, and transport materials to storage areas before shipment to markets 125-185 miles away. Household preparation of cans, glass and paper is minimal in order to boost participation. Thirty homes are serviced per hour in the highly streamlined and efficient separate collection of each fraction (multiple pass system). The system is said to be operating at a profit in these two areas of highly professional residents. Two other towns of working class residents were dropped from the scheme because of low participation. (9)

8.5 Processing Centres Fed by Satellites

The term "satellite" refers to a network of drop-off centres in the environs of a central handling facility. Materials amassed at drop-off centres are usually delivered to the central site in a centrally dispatched or organized trucking system. In this sense, the current proposal in Lincoln County is a satellite system. The definition fits "milk run" pickup operations which service bins positioned at apartments and businesses, in many U.S. ecology group and non-profit source separation programs. Individual deliveries from decentralized drop-off points are more rare. Economies of scale are evident in this central handling, processing and marketing of recyclables.

A satellite system was proposed for an urban Connecticut community in 1976. It was a program jointly designed by an intermediate processor, and a coalition of anti-poverty groups, but was abandoned when a mechanical resource recovery plant was slated for the area. A brief description of the proposed source separation package is outlined below for its potential application to rural source separation system designs.

The kingpin of the comprehensive source separation system was to be a 500-ton per day intermediate processing plant, modeled on an existing but smaller capacity front-end plant operated by a nearby intermediate processor. This operation is discussed in greater detail in Section 10. Employing 75-80 people, the plant would not only house a factory operation to process recyclables for shipment to market, but would also provide the following services for the rest of the linkage: planning, design, personnel training, public relations, parts supply, marketing, computer and legal services, accounting, research and development, publishing and advertizing. With an annual revenue of just under \$4,000,000 and operating expenses of slightly over \$2,300,000, the net profit of \$1,500,000 would be distributed to collection points as payments for "raw" materials.

Several hundred existing collection points operated by commercial, municipal, institutional and community agencies were to feed the plant's medium-technology, front-end materials processing line. Upgrading and volume reduction would include paper baling, glass sorting and crushing, magnetic separation of ferrous from aluminum cans and can shredding. Collection point bins provided by the central plant would be routinely picked up when full by trucks from the plant. A computerized trip ticket system would identify collection points for profit-sharing.

Economic feasibility was to be the key principle behind system operation. The plant would consistently process a high-quality product and be able to ship in high volumes. Neither achievement was thought to be possible for small, ecologically motivated source separation programs. A total marketing concept was developed in order to avoid any costly weak links by:

- Designing techniques for estimating local recyclables generation
- Choosing the most profitable fractions and searching for additional fractions to diversify the revenue base
- Standardizing processing for maximum efficiency while assuring that processing techniques are flexible enough to meet specifications of buyers
- Anticipating market price fluctuations and searching for alternate markets
- Obtaining information on shipping arrangements and off-loading requirements
- Designing a formula for calculating cost-benefit evaluations

In this scheme, further economy was to be achieved in the transfer of recyclables from collection points to plant through the use of satellites. These were to be independent local contractors who would amass materials from many collection points in a local area for shipment to the plant. Three options were under discussion for this satellite operation:

- A location would be established for a large flat-bed (28-bin capacity) trailer to receive bins collected from many points by the satellite operator who would use a 10-bin capacity, boom-equipped truck. When the flat bed trailer was nearly full, the central plant would dispatch a new trailer bearing bins for the contractor's use.
- A bulk container truck would be located at the satellite station to receive the contents of bins emptied by the contractor. As above, the full truck would be exchanged for an empty truck dispatched by the plant, but in this case bulk mixed recyclables would require more plant processing.

- A bulk roll-off container would be located at the satellite station to receive mixed recyclables as in the second option. The container would be serviced by centrally dispatched trucks.

In each case trucks/bulk containers and bins are provided by the plant. The first option is the most costly because it requires an expensive boom hoist. The third option is least costly because one tractor cab can service many satellites. The chief advantage of these transport systems is the reduced number of trucks, trips and fuel necessary for delivery of materials to the plant. Plant efficiencies would also be increased by less traffic and bulk deliveries.

Another function of the satellite location, besides serving as a transfer station for recyclables, is to indicate the feasibility of establishing another processing centre in the locality. Initially the satellite-collected materials would be fed into a central facility but as the system expands, additional regional processing centres could be established to independently receive, process and ship out materials, still sharing non-factory central services of the original plant. The transition from satellite to processing subcentre would be determined by optimum criteria: local tonnage available, container cost, trucking cost (to market vs. to central site) and original plant capacity (surplus vs. maximum). In other words, it may become more economical to process and ship to market locally than to transfer non-volume-reduced materials to a central plant.

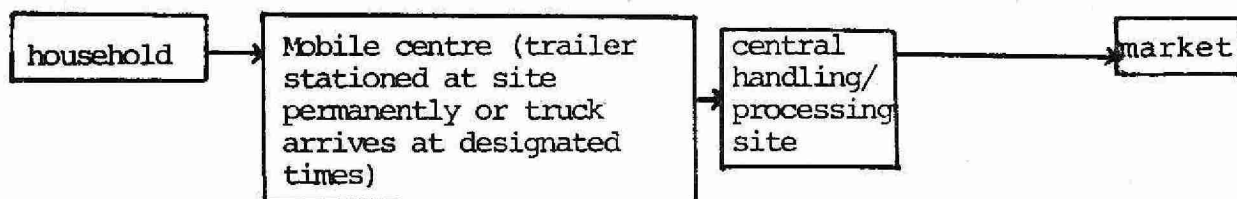
A summary of this total expanded concept would place a service operation at the top of a pyramid followed by a processing centre level. Service fees, lease and other capital payments would pass upwards to the co-ordination level in exchange for services to the centres: legal, marketing, accounting, personnel, public relations, and so forth. Each processing centre would buy recyclables from collection points and/or satellite stations.(10)

8.6 Summary and Conclusions

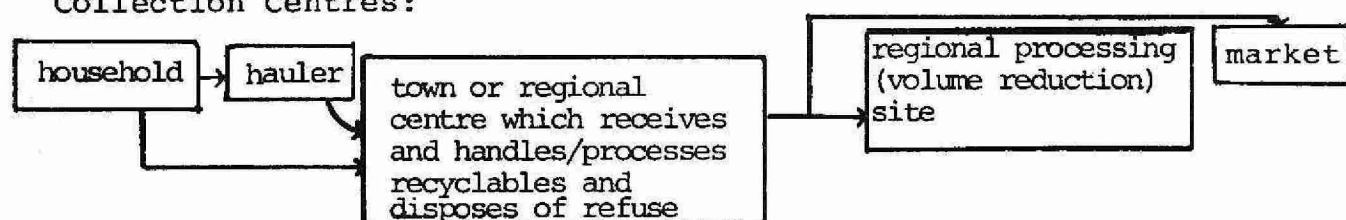
In this section three rural source separation program models are examined: mobile dropoff centres run by non-profit businesses, a door-to-door commercial pickup service, and collection centres for recyclables run by local towns. In the latter system, with varying degrees of regionalization, reclamation is integrated with overall waste management in contrast to the former two. Satellite operations linked to intermediate processing centres proposed for an urban area is also illustrated because it is applicable to rural areas. The flow of recyclables can be schematically expressed as follows:

Diagram 1: Materials Flow for Four Source Separation System Designs

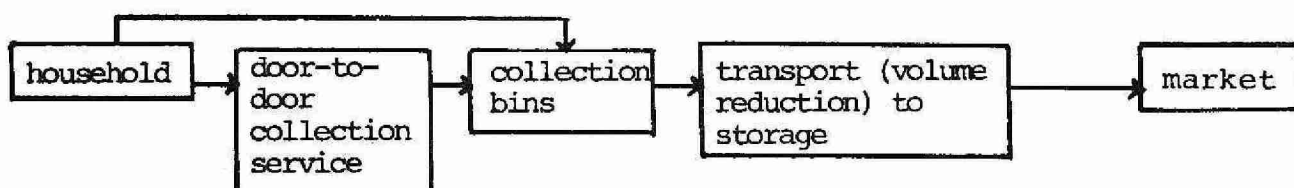
Mobile Systems:



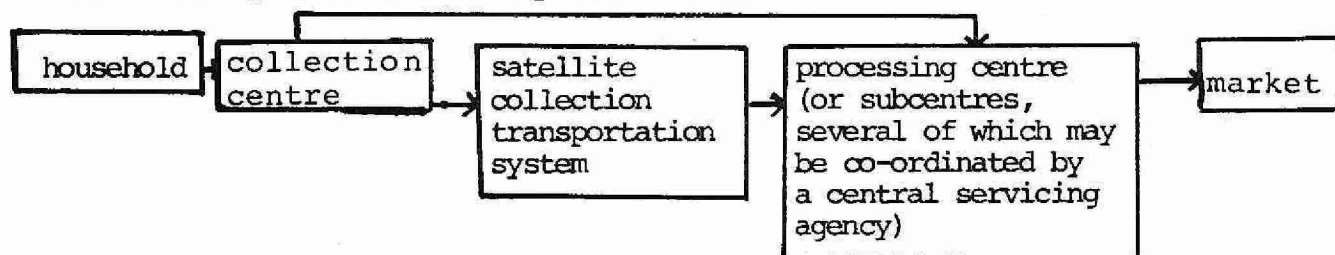
Collection Centres:



Door-to-Door Collection:



Processing Centres Fed by Satellites:



Taking examples from this and other sections of this report, the following table combines the inputs, outputs, services and business spin-offs associated with a comprehensive rural/regional source separation system:

Table 12: Aspects of a Comprehensive Rural/Regional Source Separation Program

Inputs: Sources of Recyclables	Central Services:	Business Spin-Offs	Outputs:
<ul style="list-style-type: none"> -individual households -individual drop-off sites -private hauler, volunteer group, or municipal curbside or door-to-door collections -satellite collection systems for various drop-off sites (landfill site, plaza, etc.) -charity groups -commercial food and paper waste -specialized industrial wastes 	<p>Hard (Equipment and Processing):</p> <ul style="list-style-type: none"> -upgrading and volume reduction (bale, crush, flatten, sort, remove contaminants) -storage -transportation to market and from satellites <p>Soft (Administrative) to rest of linkage and to processing substations who perform own "hard" services:</p> <ul style="list-style-type: none"> -market research and marketing -hauling route organization -volume purchasing of equipment -payments for materials -estimate feasibility of substations -fees for services (planning and design, personnel training, public relations, publishing and advertizing, maintenance and parts supply, financial and accounting, legal, R & D, education) <p>Refuse: if handled</p> <ul style="list-style-type: none"> -transfer to landfill -incineration to heat processing plant, offices and other operations 	<ul style="list-style-type: none"> -resale store outlet -compost farm -records shredding -bottle washing and resale -craft, repair, refinishing workshops -free or fee-based waste exchange -cellulose insulation 	<ul style="list-style-type: none"> -refillable bottles -reusable bottles (formerly considered non-refillable and non-returnable) -compost -refurbished furniture, appliances, clothing, toys -shipments of: corrugated, news, fine paper, glass cullet, metal, rubber tires, waste oil, rags, to local and regional markets -other reusable goods: egg cartons, plastic tubs, paper bags, baskets, for merchants

Based on other sections of this report, such an operation could be financed by lending institutions, and government grants for job-creation and small business development. Sponsorship could combine sectors through: direction from higher government levels and industrial associations; implementation by municipalities, non-profit companies or for-profit enterprise; and staffing from paid volunteer and rehabilitative labour pools.

Cottage industries, run by socially marginal entrepreneurs and handicapped or prison "half-way" groups, could add a social service value and a broadened funding base. Co-operative management could be an alternative to conventional business structures. The operation could be phased in by first establishing a single processing centre for simple volume reduction and upgrading, while "soft" service skills and added sources of recyclables are amassed. Business spin-offs and the integration of refuse management could follow.

The location of such a plant would have to be determined on the basis of 1) sources of, 2) markets for, and 3) haul options for materials. A demonstration program requires further research tasks:

- An inventory of existing source separation programs.
- The plotting of potential source separate materials generating areas (where there are no existing programs).
- An inventory of markets (based on the key questions posed to buyers as listed in Section 6).
- The plotting of haul routes, particularly in areas where there are a number of existing source separation programs which could be co-operating in marketing. As concluded in Section 6, a listing of back-haul networks would be particularly applicable to more remote areas of Ontario.

This conclusion is based on the assumption that regional co-operation in processing (volume reduction, upgrading), marketing and hauling will enhance the economic viability of source separation. This assumption would apply not only to rural areas but also to urban areas, especially those without local markets for recyclables.

SECTION 9

SOURCE SEPARATION IN APARTMENTS: SYSTEMS DESIGNED FOR HIGH
POPULATION DENSITY SITUATIONS9.1 Introduction

Source separate collection from multiple dwellings is of interest because of the potential for economies of scale not possible for other modes of habitation. Apartments offer a high concentration of residents and reclaimable materials along with centralized waste handling facilities. Despite these advantages, apartment dwellers are sociologically associated with low community participation in general. There are physical storage constraints in apartment buildings, and existing facilities are not designed for segregated materials handling.

With some notable exceptions, few innovative developments are occurring in source separation for apartment buildings. Where there are initiatives, there is little printed documentation.

9.2 Government Activity

The U.S. EPA reports some interest in helping to initiate programs in garden apartments, but recently cancelled funding for a pilot scheme in Seattle due to failed negotiations with the private hauler involved. Staff, when pressed, did think of one example of source separation in an apartment building citing the retirement community of Bocca Ratone, Florida, north of Miami. Good tonnages have resulted, apparently because of the unusually high consumption of imported newspapers such as the Wall Street Journal. (1)

A top Oregon official concurred with EPA staff that superintendent and private hauler apartment reclamation activity is vigorous, but undocumented and not organized on the U.S. west coast. He knew, but could not provide details or references, about a Swedish company installing pneumatic devices for source separated materials in new and old apartment buildings. (2) In Massachusetts, where more than half of all communities in the state are engaged in reclamation efforts, there is no apartment source separation in the capital city of Boston. (3)

In the course of this research, many municipal officials have been contacted about source separation in general and apartments in specific. According to these officials, in many smaller U.S. cities with municipal paper collections, apartments are treated like single family dwellings in that newspapers are collected from apartment compactor areas or from curbside. No special techniques are being used.

9.3 Buyer Initiatives

Garden State Paper Company, one of the largest U.S. consumers of waste newspaper for its recycling plants, reports that apartment complexes are unresearched. "Aside from the time-honoured role of the scavenger, hauling bundled paper out of the basement/incinerator room, there has been little, if any, research performed on apartments." The company had planned to hire a consultant in 1978 to assist in understanding apartment reclamation problems. (In March 1978, the Company reports that the investigation is still planned but yet not underway.) (4)

Normally, paper dealers interested in tapping apartment newspaper waste, make initial approaches to resident building management who then design internal systems. (5) (6) There is much action in the U.S. east coast cities where superintendents unofficially reclaim paper from apartments. These techniques are not documented and efforts among supers are not organized. (7)

In Edmonton, Alberta, Paperecycle Alberta is a twenty-five year old scrap paper dealer which acquires waste paper from many sources, including apartment complexes. The company has a pamphlet on how to design a paper drive but cannot provide details specifically for apartment complexes because staff leave organization of fundraising drives to tenants groups, clubs, charities and superintendents. Another procedure is followed for buildings with mandatory separation. For instance, in one 640-suite building, it has always been illegal for tenants to combine bottles and paper with trash put into refuse chutes. The cleaning staff transfer bottles and paper from chute rooms to a central dumper. Paperecycle removes paper from such buildings but does not pay for the product as building managers are content with saving disposal costs. (8)

An exception to leaving reclamation to tenant organizations or superintendents is found in a Winnipeg program. WeatherCheck, a native people's insulation company, arranges for the use of apartment freight elevators on a designated day of the week. Floor by floor, refuse rooms are emptied of bundled newspaper, placed there the night before by participating tenants. WeatherCheck workers perform the work and do not pay for the paper. (9)

9.4 Non-Profit and Volunteer Group Activity

Many west coast ecology and non-profit groups station bins or drums in apartment buildings near compactor units as drop-off points for participating tenants. In one study, reference is made to a St. Petersburg, Florida satellite program where some thirty-four

stations are located at apartment houses for newspaper deposit. Economies of scale result because a collection route has been devised to minimize distances travelled, and collection labour required.(10) A non-profit ecology group and a commercial hauler, both on the U.S. west coast, intend to add apartments to successful residential pickup programs now that "the bugs" are ironed out of pilot areas. The sponsors of these programs are the Modesto Ecology Action Education Institute(11) and the San Luis Obispo Garbage Company (not non-profit)(12), respectively.

A company called Ecocycle of Boulder Colorado was referred to by several interviewees as a source of information of source separation in apartment buildings. However, Ecocycle terms its efforts as "disaster" especially in large buildings. Having tried programs in a range of low- to upper-class buildings of varying sizes, the main barriers have been internal storage, inability to put materials at curbside and the failure of tenants to respond to the most vigorous publicity techniques. Ecocycle recommends programs only for small apartments (15-20 units) where 55-gallon drums can be placed next to trash bins used by tenants.(13)

Within the Cambridge, Massachusetts Housing Authority, a non-profit business has been set up with joint goals of recycling and job-creation for low-income minority youth. With several grants and subsidies the organization has enlisted the participation of 3,000-4,000 public housing units, provides buckets for source separated materials and offers a pickup service once or twice per week for each family by appointment. Buckets are not left in hallways because of children and dogs. "Residents Recycling" does no processing and uses a middle man who provides a bulk container, pays an average of \$15/ton and markets materials: rags, paper, aluminum, "tin" cans, glass and scrap metal. The program co-ordinator thinks that the program can break even without grants and claims that the youth employment pitch is responsible for high participation in contrast to the usual apathy in public housing.(14)

The National Black Veterans Organization recently received federal funding in the U.S. as a joint job-creation and recycling model operation. As in Residents Recycling, NBVO collects from public housing units, but procedures used are similar to Paperecycle Alberta: minimizing their own role, NVBO assists and shares profits with community groups who organize drives. In Washington, D.C. buildings, where papers are normally left stacked in refuse rooms instead of being put down chutes, it is the role of staff to collect and store paper for NVBO pickup. Janitors are sometimes paid for this paper. Where there are tenants' associations, residents help with publicity posters and flyers and may or may not share revenues. In all cases (except

where paper is not allowed down chutes), participation is voluntary and ranges from 50% to 80%. Much attention is given to ongoing publicity and careful streamlining of collection procedures to minimize costs. Aluminum and all grades of waste paper are collected now with glass and "tin" cans scheduled for the future. (15)

9.5 Apartment Source Separation in Ontario

In 1977, the Waste Management Branch (then the Resource Recovery Branch) of the Ontario Ministry of the Environment did an "unsystematic survey" of source separation in Ontario and found no apartment building programs except for a failed attempt in London, Ontario. (16) There are municipal collections of newspaper in Southern Ontario which do not exclude apartments on residential routes. There is the same superintendent and buyer activity as elsewhere, when paper prices are high.

To illustrate the components of an apartment source separation scheme, two Toronto examples are charted below:

Table 13: Comparison of Source Separation Programs in Two Toronto Apartment Complexes

Component	20 Prince Arthur(17)	Village Green(18)
description of building	1 tower of 20 floors; 195 suites; 250 tenants	3 towers (23 floors, 18 floors, 18 floors); 700 suites; approximately 1260 tenants
socioeconomic status	downtown professionals and business persons	same
existing wastes handling	refuse rooms on each floor; refuse put down chutes; bottles and papers piled here removed daily by cleaners who transfer them to City of Toronto dumper in basement, provided at no cost (papers not allowed down chutes for four years because of plugging problems)	refuse rooms on each floor; all garbage put down chutes-- signs posted say no trash to be left on floor of room; compacted trash picked up by City of Toronto at no additional cost
paper reclamation motivational impetus	paper dealer approached resident building manager who got support of superintendent to do the work involved in return for share of revenue	concerned individual found out about 20 Prince Arthur, got co-operation of tenants association and building manager to carry out volunteer program

Table 13 (continued)

market	Paper Recycling Co., 44 Eglinton Ave. W., Toronto	same
sales terms and revenue recipients	\$15/ton split among cleaning staff; 1' high bundles (35-40 pounds each); no magazines and no minimum pickup limits	same price and preparation re- quirements; profits to tenant association
labour	cleaning staff	volunteers from tenant association
publicity	paper dealer provides simple half-sheet signs advertizing paper re- clamation; posted in refuse rooms	same
preparation and set-out rules	tenants asked to tie flat papers in foot- high bundles and bring as usual to refuse room; bundles under one foot and loose papers are bundled by super	tenants asked to tie flat papers in foot-high bundles and store in unit until weekly set- out time when they stack papers on floor of refuse rooms; loose paper and bundles under one foot are rejec- ted by volunteer workers and discar- ded down chutes
handling procedures and storage	cleaners daily remove papers from refuse rooms in cardboard boxes mounted on wheels; super re-bundles as necessary and stores 35-40 bundles in his own unit and calls for pickup once every two weeks	on same day each week, and after morning elevator rush hour, volunteer teams from each building transfer papers stacked in refuse rooms onto adjoining elevators for trip to base- ment level; papers put into awaiting truck with no other intermediate storage
hauling	contracted out for a commission of \$15/ton (company sells paper for \$60/ton and after paying \$15 to building and \$15 to hauler, makes \$30/ton)	same

Table 13 (continued)

diverted disposal and revenues	35-40 bundles (40 pounds each) every two weeks amounts to 1400-1600 pounds for \$21-\$24; .40-.60 pounds per person per day	not known but expected to be less proportionately than 20 Prince Arthur because: papers allowed down chutes; in-unit storage problem over one week period, effort of tying and stacking paper in refuse rooms on designated day only, and policy of rejecting improperly prepared materials (loose and bundles less than one foot high)
organizational hurdles and physical constraints	no organizational problems because residential building management willing, and clearance obtained from management company; storage problem overcome when super willing to stack paper in own unit; no in-unit storage required of tenants	volunteer recruitment; resistance of resident building manager and clearance problem from property management company; zero central storage meant that a drop-off point could not be designated in a central place; no storage allowed in refuse rooms except overnight before transfer to truck
alternatives without dealer	source separated newspapers, set at curbside on Wednesdays by tenants or super, would be picked up by City of Toronto truck	source separated newspaper, set at curbside on Wednesdays by individual tenants, super or volunteer group, would be picked up by City only if requested as for rest of "core" area

Comments

It can be seen that storage constraints in these apartment buildings are a serious problem but in the second case these are overcome with an ingenious volunteer design. In both cases the co-operation of resident building management is essential but in neither case is there the incentive to save on disposal cost by diverting material for recovery. Finally, both cases

are entirely dependent on viability of markets. If newspaper prices fall and Paper Recycling Company no longer buys the paper, neither the super nor the volunteer group will continue to reclaim paper. However, the first example (because papers are not allowed down the chute and because a super responds more quickly to approaches from markets) is not lost to future market surges. (In fact both programs were terminated in May, 1978 when cellulose insulation markets slumped.)

9.6 Summary and Conclusions

To summarize the state of the art in apartment building source separation in other jurisdictions, some observations can be made. There are three "sponsorship modes" for collection: 1) Curbside paper set-outs, and centrally stacked paper in refuse areas, are picked up as part of municipal paper collections. 2) Special paper collection arrangements are made between apartment superintendents, or tenants' organizations, and paper buyers. 3) Pickup programs for paper and other recyclables are sponsored by ecology groups, social agencies, and on a less regular basis by fund-raising organizations. For fund-raiser and superintendent-type schemes, where the motivation is profit, reclamation is dependent on market prices. Consequently, programs in the municipal and non-profit categories are more reliable. (Apartments are serviced along with other sources, and tenants, rather than the superintendents, are responsible for preparation and set-out.)

Conditions influencing the feasibility of apartment source separation are building size and existing refuse handling practices. Small buildings with low-rise construction are more likely to require tenant refuse disposal, without intervening chutes or superintendents. Thus drop-off points for recyclables can be placed near refuse disposal points. Where bottles and newspaper cannot be put down refuse chutes, the opportunity for marketing pre-separated materials is excellent.

Despite cynicism over some failed apartment programs, there is still interest on the part of government and corporate officials to take advantage of the economies of scale in multiple dwellings. Development of specialized waste handling equipment and modification of existing facilities are not essential. Drums for small buildings and for satellite stations, and conventional vans and packers are being used for collection. The chief concern is human motivation, in attracting the co-operation of building management and of tenants.

Based on information from other jurisdictions and from limited examples in Toronto, the following action may be taken:

- Discussion should be initiated with government housing authorities whose jurisdictions include building design standards and funding (OHC, CMHC) in order to address the problem of storage space for recyclables in multiple dwellings. Storage problems arise with respect to individual units, to floor space in refuse rooms, and to central wastes handling areas.
- Discussion could be started with associations related to apartment building design (architects, developers). Despite high costs for open and storage space in urban structures, an appeal could be made on the basis of savings in diverted disposal for building management where reclamation is practiced. Cost data on additional chutes for newspaper should be compiled.
- Investigation could be made of Swedish social and mechanical techniques used in apartment buildings as segregation of waste paper has been made a legal obligation of both households and municipalities throughout that country.(19)
- While there is no assurance that techniques which work in one building are transferable to other buildings, there is enough general knowledge of system design for the production of a guide that outlines steps for starting and maintaining an apartment source separation program. Such a guide or manual should be produced for public enquiries and include basic principles for marketing and publicity. The following variations could be reduced to four or five hypothetical examples:
 1. Storage space survey: chute rooms, ground floor, sub-basements (inside); sheds, dumpers, bins (outside).
 2. Co-operation necessary from: management company, resident management, superintendent, tenants organization, individuals.
 3. Labour pool for internal collection: superintendent, tenant organization, in-building club, individuals.
 4. Existing refuse handling procedures: everything down chutes, existing mandatory waste separation, individuals (tenants) set out garbage, handling only at central compactor facility, handling in chute rooms, curbside set-out of materials assembled by supers in small buildings (building management).

5. Normal refuse service (for determining incentives for source separation): provided by management company, contracted by individual building/owner, municipal service.
 6. Source separate collection from building: charitable group, non-profit ecology group, usual waste hauler, municipal special collection (in each case, on request or regular basis).
 7. Revenue to: superintendent, tenant organization, charitable group, in-building service club, individual who does the work.
 8. Savings to: management company, resident management, municipality.
 9. Source separation drop-off location: chute rooms, central storage area, curbside set-out (each with consequences for participation).
- In addition to stimulating apartment building source separation by initiating discussion and providing guidelines as mentioned above, it would also be useful to test various operating systems applicable to apartment buildings. To this end, some form of financial incentive or subsidy could be given to existing source separation programs for purposes of including apartment building test components in collection operations currently oriented to single family dwelling occupants.

SECTION 10

SOURCE SEPARATE MATERIALS PROCESSING10.1 Introduction

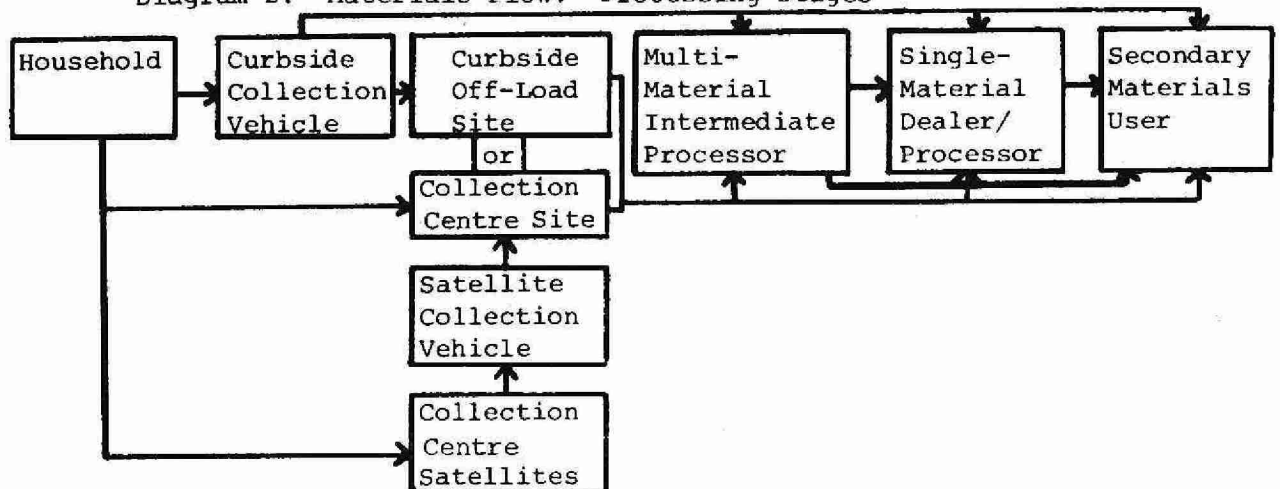
From household source to secondary materials user, source separated materials undergo varying degrees of processing. Processing changes the condition of source separated material, and includes volume reduction and upgrading. Volume reduction activities decrease material bulk. Upgrading activities improve material quality. Under most circumstances, volume reduction is considered a form of upgrading.

In this section processing stages, activities, and purposes, will be explained. There will be special emphasis on "intermediate processing" because of its significance in the U.S. and its applicability to Ontario regional source separation systems.

The model below points out the stages at which processing can occur in source separation systems. Generally speaking, when more processing is performed at further stages in the model, less processing is done at earlier stages. The converse is also true; however, mechanically sophisticated processing does not occur at the earlier stages.

Processing considerations related to one stage cannot be isolated from processing considerations at other stages in the materials flow. For example, the decision to process materials at an off-load site/collection centre site is tied to the specifications of material buyer(s), constraints related to collection (collection site/collection vehicle), and concerns about householder participation.

Diagram 2: Materials Flow: Processing Stages



10.2 The Specifications of Secondary Materials Users

Secondary materials users are industries which re-process recovered waste into new products, or re-use recovered waste in the course of producing their products. More information about secondary materials users is found in Section 6 on marketing. Although technical details about secondary material user processing activities are beyond the scope of this report, it is important to look at this last stage in the materials flow because the specifications of users determine processing activities at earlier stages.

"Specifications" are guidelines set by secondary materials users, and state the conditions under which waste materials are accepted. Specifications include such factors as material quality, material quantity, material delivery frequency, and preparation of material for efficient further handling. While materials that do not meet exact specifications may be acceptable to users, suppliers of such materials are usually paid lower revenues than suppliers who can meet the exact specifications. Thus, suppliers are often faced with the decision of whether to meet exact specifications and thereby expend the most effort and obtain the highest possible revenues, or to not meet exact specifications and thereby reduce effort and obtain lower revenues. In some cases materials are accepted by users only if exact specifications are met by suppliers.

The following review of the three major materials, i.e., paper, glass, and metal, illustrates how user specifications affect other stages in the residential materials flow:

- Paper: The U.S. newsprint recycling industry requires dry, unsunburnt newspaper, devoid of all contaminants except paper bags and sometimes telephone directories. The cellulosic insulation industry has the same general waste material quality standards as the newsprint recycling industry. Paper mills which produce boxboard, kraft paper, and newsprint, accept certain materials available from residential source separation programs such as newspaper and brown paper bags. The building materials industry can tolerate mixed paper grades which include boxboard, junk mail, egg cartons, and glossy magazines, for such products as insulite board, asphalt shingles, and compressed board. Most of these waste paper users prefer high quality (sorted) paper in large quantities on a regular basis in baled (easier to store and handle) form; however, small-scale insulation companies sometimes prefer unbaled paper on a seasonal basis, and, as noted, building materials manufacturers accept mixed grades. While source separation programs can partially meet user specifications through educating householders about

material quality, other specifications can be met only through additional sorting, mechanical baling, and long-term storage of paper at program sites. As the related costs of meeting user specifications are sometimes prohibitive for small-scale source separation programs, many programs sell to paperstock dealers whose operations and higher throughputs are geared to meeting user specifications. Also, some users prefer to purchase only from the dealer sector because of the users' needs for regular, high quality, high quantity deliveries. For instance, Garden State Paper Co., the major U.S. newsprint recycling industry, prefers to buy from dealers, and buys directly from source separation programs only where there is no active dealer sector.

- Glass: Glass container manufacturers ideally require kiln-ready cullet--clean waste glass, crushed into small particles and devoid of any metal or ceramic contamination. Some glass manufacturers produce only flint/clear glass products, and purchase only flint/clear cullet. Other manufacturers also produce amber and green glass products, and purchase green cullet and amber/brown cullet. Colour mixed (green + brown + flint) cullet, which can form a percentage of the "raw" material, added to green and brown glass batches, is acceptable to glass manufacturers who produce a substantial amount of green/amber glass. Specifications for small particle size are rigid in the U.S. northeast where glass manufacturers rarely purchase waste glass directly from residential source separation programs, whereas glass manufacturers in the mid-west and west coast accept larger particle sizes from a variety of suppliers. Industries which manufacture construction materials, such as foam glass insulation, glassphalt and columnar composite pipe, accept dirty waste glass in the U.S., but such markets are limited.(1) The beverage industries which use refillable and re-usable containers in their bottling operations, accept unbroken glass bottles of suitable size and shape. Specifications for sterile bottles are made by bottlers which do not carry out their own washing operations and are supplied by independent bottle washing companies, currently found in the U.S. west and south-west only.
- Metal: The steel industry, which recycles scrap steel, is a user of "tin" cans that have been de-tinned and compressed into bales. The copper mining industry, which re-uses "tin" cans in the mining process, requires low densities per unit of volume of material and can tolerate non-metallic contaminants, but wetness must be minimal. The aluminum industry recycles waste aluminum foil, cans, and food plates, that have been separated from ferrous metals. Before the scrap aluminum is melted and cast into sheet ingot for further product manufacture, it must be shredded either by the aluminum industry or by suppliers.(2)

10.3 The Role of Single-Material Dealers and Processors

Meeting the exact specifications of secondary materials users is often beyond the technical and/or financial capabilities of source separation programs. Meeting user specifications can be accomplished through intermediaries which upgrade a single material for resale to users. The traditional intermediaries are paper-stock dealers, scrap metal dealers, and the de-tinning industry. Since source separation programs cannot provide de-tinned steel to users, "tin" cans must be processed by the de-tinning industry. Dealers sort and shred and/or bale paper and metal for resale to users. When source separation programs market materials to dealers, the specifications of dealers have to be met at prior stages in the materials flow. Since dealers perform upgrading and volume reduction, their specifications are less rigid in that they accept materials from suppliers who provide material that may be low in quality, in small quantities, available on an irregular basis and not prepared for efficient handling--conditions which would be unacceptable to most secondary materials users. Although dealer revenues paid to suppliers may increase with the degree to which specifications are met, dealer revenues reflect processing and other costs, and are therefore lower than user revenues paid. Despite lower revenues paid, the decision to market to dealers instead of users usually eliminates the need for processing by a source separation program and often requires less effort on the part of household participants. The processing activities of single-material processors and dealers are not innovative and will not be elaborated further.

10.4 The Role of Multi-Material Processors

While the traditional intermediaries process a single material, i.e., paper or metal, a new form of intermediary, which processes more than one material, has emerged in the U.S. Called "intermediate processors," these middlemen accept and process metal and glass (and one accepts paper also) from multi-material source separation programs in the northeast and west, and market processed materials to secondary materials users and sometimes to single-material dealers/processors.

According to the U.S., E.P.A., there are only three intermediate processors in the country and all are located in the northeast. These processors emerged during a specific phase in the development of source separation, when public enthusiasm for source separation was not equally matched by secondary materials users, especially the glass container industry which was unwilling to accept increasingly available but contaminated, post-consumer waste material.(3) In addition to the three northeast intermediate processors cited by

E.P.A. staff, there is a west coast cullet dealer which has begun to handle metal and paper; therefore this company could be considered a multi-material intermediate processor. The four companies, and areas served in 1978 are as follows:

- Matcon Inc. (formerly called Recor Inc.), located in Salem, Massachusetts, and serving the greater Boston area;
- Recycling Enterprises Inc. (R.E.I.), located in North Oxford, Massachusetts, and serving western Massachusetts, neighbouring New England States, western New York State, and the northern mid-Atlantic region;
- Resource Recovery Systems Inc. (R.R.S.), located in Branford, Connecticut, and serving the greater New Haven area and nearby Waterbury;
- The Sessler Company Inc., located in South Gate, California, and serving Downey, a suburb of Los Angeles.

A. Matcon Inc.

When operated as Recor Inc., this company had two plants. The Salem, Massachusetts plant processed paper, glass, and cans, and the Dayville, Connecticut plant further upgraded glass to meet the exact specifications of a glass container manufacturer in Dayville. While the Dayville Recor plant received partially processed glass from the Salem Recor plant, the Dayville plant's main source of supply was the Dayville glass container manufacturer, which bought glass from source separation programs, sold it to Recor for upgrading, and bought it back for recycling. The value of scrap metal in 1974 was \$100 per ton and, along with high paper prices and a favourable arrangement with a glass container manufacturer, Recor's future appeared bright. At the time, Recor accepted mixed paper, and co-mingled glass and metal, i.e., colour mixed glass mixed with aluminum and "tin" cans (equivalent to five fractions of glass and metal).

According to a 1977 consulting report(4), Recor was operating five days per week on a single shift with seven workers. Throughput was sixty-eight tons of paper and forty tons of glass/cans per day. Annually, this throughput amounted to 50,000 and 27,000 tons respectively. With a gross annual operating cost of \$695,000 (includes wages, maintenance costs, transportation costs, and purchase of recyclables, but does not include capital investments totaling \$250,000 between 1974 and 1977) at the Salem plant, Recor was delivering its product for under \$10 per ton.

According to the same consulting report, the Recor process line for mixed paper included manual removal of non-fibre contaminants from paper on a conveyor leading to a shredder. Shredded paper was pneumatically moved to a baler, and then warehoused before shipment by truck and rail box car to mills in New England or as distant as Indiana. The glass/cans process line started with a 2" vibrating screen conveyor. Pieces smaller than 2" (broken glass, metal caps and rings, etc.) passed through the screen and were conveyed to a contaminated glass bin. Pieces larger than 2" (glass, cans, and large contaminants) were conveyed to a magnetic drum for removal of ferrous metal. This ferrous fraction was mechanically shredded and stored for shipment to the de-tinning industry. The aluminum cans, which were not attracted by the magnetic field, were hand sorted from the conveyor and placed into a bin for shipment to smelters. The glass remaining on the process line was added to the contaminated glass bin and shipped to the Dayville plant for further upgrading through crushing and removal of metallic and ceramic contaminants.

By 1978, several changes have occurred in the Recor operation. Under the new name of Matcon Inc., paper processing has been dropped, and the Dayville plant operation has been stopped since the glass container manufacturer ceased to buy glass from source separation programs. At the Salem plant, pieces of (contaminated) glass, smaller than the 2" screen, are treated as refuse. Larger pieces of glass are crushed in a hammermill after ceramic contaminants have been hand-picked, and after cans have been re-routed manually onto an auxiliary conveyor. When co-mingled ferrous and aluminum cans are returned to the main conveyor line, ferrous cans are still magnetically separated from aluminum cans, but ferrous shredding has been abandoned (because shredder blades were constantly destroyed by tramp iron). Ferrous is now flattened under the wheels of a front loader, and aluminum is shredded in the hammermill. On-site processing costs have climbed to \$30 per ton.

The Matcon plant operates for two, three, or four days per week, and employs three full-time staff and miscellaneous part-time workers. Throughput averages a maximum of twenty tons of glass/cans per hour, or 800-1,200 tons per month. Matcon markets ferrous to the de-tinning industry at a much lower price (\$20 per ton now vs. \$100 per ton previously) than its 1974 value. The company ships aluminum to buyers (unspecified), but at high shipping costs per unit of volume.

Problems are being experienced in marketing glass. In spring of 1974, the Dayville plant stopped accepting colour mixed glass. Since Matcon does not colour separate glass, it cannot protect its own suppliers of coloured mixed glass from the fall in demand for colour mixed glass; consequently Matcon has stopped accepting colour mixed glass. Matcon's source separation program suppliers have been forced into sorting colours of glass at program sites, or informing householders to colour sort, or collecting only clear/flint glass. (The change to saving flint-only is thought to be easier for householders than the change to sorting into three colours, once the habit of colour mixing three colours has been established.) Suppliers of flint glass and mixed green/brown glass are unaffected by the change in user specifications; however, in mid-1978, Matcon began to experience difficulty in marketing pure green cullet and pure amber cullet. The difficulty is attributed to new returnable (but not refillable) beverage container legislation in a nearby State. The legislation is blamed for a surplus of green and brown cullet.(5)

B. Recycling Enterprises Inc.

R.E.I. appears to be the most prosperous of the three northeast U.S. intermediate processors with a new plant, plans for plant expansion, and optimism about techniques for optical (mechanical rather than manual) sorting of colour mixed glass. In 1978, R.E.I. accepts only colour sorted glass. R.E.I. also accepts co-mingled "tin"/aluminum cans, which are being stockpiled for a can line under construction for start up in the immediate future. Since glass arrives colour sorted, R.E.I.'s processing line involves separate processing of each colour of glass. Ceramic and other non-metallic contaminants are hand-picked from a conveyor along which glass passes before it is smashed in a specially adapted hammermill and freed of metal contaminants by a "secret" sifting process.

The R.E.I. plant operates for twelve hours per day, and seven days per week in order to maximize utilization of existing equipment. Staff include 30-35 people who administer the operation; process and warehouse materials; manufacture roll-off bins and other equipment for the existing glass line and future can line; perform maintenance; and service suppliers with pickup service via bulk lift trucks. Maximum throughput is fifteen tons of glass per hour. Breakeven throughput is estimated to be 3,000 tons of glass per month, and 5,000 tons of glass per month are slated for processing when a second glass line is started up in the immediate future.

R.E.I. cites a processing cost of \$10 per ton and appears to have no difficulty marketing its processed glass to plate and container manufacturers.(6)

C. Resource Recovery Systems Inc.

R.R.S. appears to make the most vigorous public relations effort compared to the other two northeast U.S. intermediate processors. (R.R.S. was the only intermediate processor which responded to enquiries from the author of this report.) In 1978, R.R.S. accepts co-mingled glass and metal, i.e., colour mixed glass mixed with aluminum and "tin" cans (equivalent to five fractions of glass and metal).

On the R.R.S. processing line for co-mingled glass and metal, ferrous is removed magnetically and re-routed to a can flattener (specially designed to avoid damage from tramp iron), while glass and aluminum continue along a conveyor. Next, aluminum is hand picked and conveyed to a flattener. The three remaining colours of glass are each hand picked, along with ceramic contamination, from the main conveyor and re-routed onto three conveyors equipped with special glass smashers and magnetic contaminant removal devices. R.R.S. is inventing a device which will sense and remove both ferrous and non-ferrous metal contaminants from glass. The processing line is continuous for all five fractions, and this means that a problem on one line requires the stoppage of the whole operation; therefore, R.R.S. is inventing a console panel which will allow all conveyors to be individually controlled. Also, because large glass pieces are easier to colour sort manually, R.R.S. is redesigning the first junction in the conveyor so that glass does not break when dropping from the magnetic head pulley that attracts ferrous cans.

The R.R.S. plant operates for five one-shift days per week and employs four sorters, a loader driver, and three administrative/clerical staff. While processing equipment has not been pushed to capacity, a throughput of 200 tons per week is thought to be possible. The R.R.S. process cost is \$15 per ton or less. Like Matcon, R.R.S. arranges, but does not provide, transportation of supplies to its site. R.R.S. does not always provide a revenue to suppliers because disposal diversion is thought to be a sufficient incentive to certain municipal source separation program operators. R.R.S. transports glass to several glass container manufacturing plants, sells "tin" cans to the de-tinning industry, and sells aluminum to various users, but is currently stockpiling aluminum because of problems related to slack demand and cost of shipping light material.

Under a federal subsidy R.R.S. is providing the technical system design and marketing services for a national minority group economic development project involving at-source recovery. (7,8,9,10,11,12,13)

D. The Sessler Company

Information about this U.S. west coast cullet dealer which has expanded into other materials, is less complete than for the northeast intermediate processors. Sessler accepts a totally co-mingled product delivered by at least one source separation program. Incoming newspaper, glass, and cans--all mixed--are separated into six components at the rate of twelve to twenty tons per hour. The process line includes a conveyor belt from which ferrous cans are magnetically removed, and newspaper, glass colours, and aluminum are hand picked. Cullet is sold to local glass container manufacturers, aluminum to an aluminum manufacturer, newsprint to dealers who export to the Far East, and "tin" cans to dealers who re-sell to the copper mining industry. (14)

10.4.1 Summary of Intermediate Processors

A significant contribution of the intermediate processors lies in their ability to meet specifications of materials users, and therefore to reduce the need for processing at earlier stages in the materials flow. In the case of the Sessler Co., no processing is required by the source separation program operator, nor are householders required to do anything other than combine all newspaper, glass, and metal for collection. While the northeast intermediate processors do not accept paper, and while their specifications and services to suppliers differ, their contribution to glass and metal source separation is apparent. In the case of R.R.S., no processing of glass or metal is required by the source separation program operator, nor are householders required to do anything other than combine all glass and metal for collection. In the case of R.E.I. whose specifications include colour separation of glass, source separation program operators are provided with roll-off containers that are divided into four compartments for flint, green, and brown glass, and co-mingled aluminum and "tin" cans; therefore, although R.E.I. suppliers must maintain a more rigid degree of separation, either at the program site and/or household level, the burden of transportation is reduced for the program operator. In the case of Matcon, initially neither program operators nor household participants had to keep glass and metal materials separate, but currently must keep at least flint/clear glass separate from green/amber glass, although either glass category may be mixed with metal. (Matcon's

change in glass specifications has actually increased, rather than decreased, the need for processing at earlier stages in the materials flow among program suppliers which were collecting colour mixed glass.)

In general, the intermediate processors reduce the need for processing at earlier stages in the materials flow by performing a mixture of processing, marketing, and transportation activities. The intermediate processors process, market, and ship large throughputs obtained from numerous suppliers. Where intermediate processors exist, source separation programs can collect partially or fully co-mingled materials; can undertake marketing negotiations with one buyer instead of several single-material dealers, processors, and users; can save storage time/costs and shipping costs by shipping to one buyer instead of several, and by shipping to closer points (R.E.I. provides both shipping containers and transportation); can save in-program upgrading costs, i.e., "tin"-aluminum separation, glass colour separation, contaminant removal, and crushing (necessary to meet material quality specifications of users); and can save in-program volume reduction costs, i.e., metal flattening/shredding, glass crushing (necessary to ship materials efficiently over distances and to meet material quality specifications of users.) The services of intermediate processors are reflected in lower revenues paid to program operators.

In providing these processing, marketing, and shipping (to and from their sites) services, intermediate processors operate processing lines with installation costs ranging from \$90,000 (R.E.I.'s glass line), to \$100,000 (Matcon's glass/metal line), to \$250,000 (R.R.S.'s glass/metal line), exclusive of site rental or capital costs and operation. Processing cost estimates range from \$10 to \$30 per ton. While the processing lines involve various degrees of labour intensity for manual sorting of materials and contaminants, the lines involve mechanical crushing and contaminant removal, and have been dubbed "medium technology" in contrast to fully manual operations and more mechanized mixed refuse front-end "recycling" plants. In developing appropriate mechanical equipment, the intermediate processors employ heavily adapted conventional industrial machinery--conveyors, crushers, and magnetic devices. The internal configurations of these machines are regarded with secrecy after years of trial and error in developing appropriate apparatus.

The intermediate processors maintain vigorous marketing activities and are capable of meeting user specifications for large quantity shipments. Although the northeast processors are having various degrees of difficulty in meeting glass buyers' quality specifications, only Matcon has failed to buffer its suppliers from fluctuations in user specifications (whereas R.R.S. is capable of colour sorting and R.E.I. accepts only colour sorted glass). Without the northeast intermediate processors,

most source separation programs would not currently be able to market unprocessed glass. Because of their processing activities and large quantity shipments, the intermediate processors are versatile in being able to deliver to various users at various distances, and can therefore re-route materials according to user demand and price changes. Nevertheless, with R.E.I. and possibly Sessler Co. as exceptions, the intermediate processors appear to be in financial difficulty.

The concept of intermediate processing has applicability to Ontario. The northeast U.S. intermediate processors operate under circumstances that are not characteristic of Ontario. These circumstances include a publicly-perceived waste disposal crisis which has raised enthusiasm for source separation alternatives, resistance from glass container manufacturers toward the acceptance of unprocessed post-consumer waste glass, the prevalence of aluminum cans in the residential metal waste stream, and the tradition of co-mingling established in some source separation programs. With appropriate modifications, the experiences of the U.S. intermediate processors could be valuable for application to Ontario. For instance, facilities could be established throughout the Province to receive glass, "tin" cans, and fibres from source separation program suppliers. "Tin" can volume reduction could be carried out for bulk shipments to the de-tinning industry, paper grades could be upgraded and baled for bulk shipments to mills and other fibre users, glass volume reduction could take place for bulk shipments to glass container manufacturers with other glass upgrading activities carried out according to processing plans of the glass industry. The establishment of intermediate processing facilities in Ontario could reduce the duplication of public education, storage, marketing and transportation activities performed by individual source separation programs.

10.5 Curbside or Collection Centre Site Processing in Source Separation Programs

10.5.1 Reasons for Processing

In many curbside source separation programs, especially those in which only one material (i.e., newspaper) is collected, materials are hauled directly from curbside routes to local markets (users or intermediaries). In other curbside programs, materials are transferred to storage containers and/or to larger vehicles for their trip to market. For instance, municipal paper collection vehicles dump into roll-off containers, or crews manually transfer paper into containers or semi-trailers at some central off-load site. In drop-off programs, comparable transfer activity occurs when patrons deposit materials into storage containers which are transferred to market or transferred into larger shipping containers/vehicles. The shipping containers/vehicles may be

provided by buyers to operators of curbside or drop-off programs. Except for the inevitable glass volume reduction through breakage during transfer, these simple hauling and transfer activities cannot be construed as processing even though the activities involve storing and warehousing. For such programs, processing is unnecessary.

On the other hand, there are source separation programs to which local markets are not available and in which simple transfer of materials is not desirable. Such programs process materials at central sites, i.e., curbside off-load sites, staffed collection centre sites. Processing activities are primarily a function of distance to market and buyer specifications.

Where markets are distant, volume reduction of glass and cans reduces the storage time/space required to aggregate large tonnages, and increases the tonnage of material that can be shipped per load, thus cutting the number of trips made to market. Large quantities of fibre are also more efficiently and effectively stored, marketed, and shipped in baled form. Upgrading of recyclables, by on-site sorting and contaminant removal, in addition to the sorting and contaminant removal performed by household participants, usually increases the market value of the recyclables. Upgrading by crushing glass, flattening/shredding cans and baling paper--activities that cannot be performed in households except for "tin" can flattening--further increases the market value of the recyclables. This upgrading may be optional for programs in which higher revenues from buyers are being sought, or may be necessary for programs in which the system design entails few preparation requirements on the part of household participants and/or collection procedures that do not permit the degree of quality control ultimately necessary, i.e., as when colour mixed glass is collected in a vehicle without separate compartments for each colour, but only colour separated glass is marketable.

Processing is carried out at source separation program sites for numerous reasons: to save storage space, to save hauling costs, to acquire markets, to obtain higher revenues from buyers, to make source separation more convenient for participants, and to eliminate the need for quality control measures at the point of collection. Nevertheless, the advantages of processing may be offset by the costs of processing. These costs include wages for paid labour and/or the administrative burden of heavy volunteer recruitment; equipment purchase, rental, maintenance, fuel; site purchase, rental, maintenance. The trade-off between level of processing effort and rate of return is a major question for designers of source separation programs.

10.5.2 Processing Activities among Programs Examined

For newspaper, and other non-residential fibres collected by source separation programs, contaminants are manually removed, and paper is baled manually or mechanically. (Baling is relatively rare since most programs sell to insulation makers, dealers, and the overseas market.)

For glass, contaminant removal is performed by hand and can be extremely time-consuming when material is heavily contaminated with caps and neck rings, and can be extremely costly when paid labour upgrades such material. A study of U.S. collection centres has found that mechanical glass crushers are the most frequently employed piece of processing equipment. (15) Glass volume is also reduced by pouring glass down chutes (causing glass breakage at the bottom) or by smashing glass with iron bars. Colour sorting is done manually on sorting tables and conveyor belts. Collection workers on vehicles or at program sites are often responsible for maintaining quality control for which householders are responsible; thus staff check for and remove occasional contaminants and improperly combined colours.

For metal, simple magnetic devices, i.e., conveyor belts with magnetic head pullies, are often employed in the U.S. to separate ferrous all-steel and bi-metal cans from the more valuable aluminum cans; alternatively, can types are manually sorted. Following such sorting, the volume of ferrous cans is often reduced by mechanical flatteners, highway rollers, or bulldozers when ferrous cans have not previously been flattened by householders, or, to a degree, by packer trucks during collection. Aluminum is sometimes shredded or flattened mechanically.

10.5.3 Examples

The following examples are provided as illustrations of on-site program processing and give insights into general processing trends.

- A. County of Sacramento, California: Newspaper delivered by rack-fitted compactors is sorted (contaminant removal) by workers paid through a federal job-subsidy program. The Garden State Paper Company pays \$6.50/ton for each ton sorted in addition to the floor price for unsorted news. (16)
- B. Nottingham System, New Hampshire: Although more than twenty towns have adopted a similar system for rural refuse and recyclables collection (see Appendix 4 for the Nottingham prototype), procedures have been documented for only five locations: Nottingham, Plymouth, Swanzey, Meredith, and Durham which serves several other nearby towns. In each of these

five locations processing varies. The variations depend on the amount of work done by householders and by materials' buyers. Attendants check for and remove caps and rings left on glass by householders, and colour sort glass in Nottingham. Glass contaminants are not removed prior to delivery or while on-site in the other locations which are served by intermediate processors. Some glass colour sorting is done by attendants in Plymouth, but is done by residents at the point of delivery in all other locations. Glass is crushed only in Nottingham which transports its glass to market in a town truck, but in all of the other locations uncrushed glass is picked up by intermediate processors or by haulers hired by the processors. Cans are now mechanically crushed in Nottingham and Plymouth, and will soon start to be crushed in towns serviced by Durham. Only in Nottingham are ferrous cans magnetically separated from aluminum. Floor mounted balers are employed for newspaper in two towns, for corrugated in three towns, and mixed paper in one town. A pit baler is employed in Durham for news, corrugated, mixed, and high-grade fibres. A hand baler is employed for newspaper in Nottingham.(17)

- C. Project Arrowhead, Duluth, Minnesota: Semi-trailers serve as mobile collection centres for urban and rural areas in this program operated by a sheltered workshop social agency. When trailers bearing recyclables in drums return to a warehouse, fractions are routed for processing. Glass is colour sorted, metal rings taken off and plastic jackets (polystyrene tubes around pop bottles) removed. This is all done manually. Corrugated and mixed papers are baled separately; high grade office paper from Arrowhead's confidential records shredding operation is baled with news for sale to insulation makers. Cans are first processed through a crusher mounted on a drum and then placed on a conveyor belt where they are hand sorted into aluminum, all-steel, and bi-metal (the latter is further shredded for a 9:1 reduction) because prices differ for each metal.(18)
- D. San Luis Obispo, California: This private hauler-operated curbside pickup scheme collects newspaper, glass, and cans in a bin-toting container train. Only cans are processed in a metal crusher provided by the metal buyer for the purpose of volume reduction prior to transport.(19)
- E. Seattle, Washington: In a pilot scheme combining voluntary source separation with mandatory limits to disposed amounts, municipally contracted crews collect recyclables in container trains and deliver newspaper,

metal and glass to a central facility. Newspaper handling is simple transfer. Metal is dumped onto a conveyor where ferrous metal is separated by a magnetic head pulley and flattened; the remaining aluminum is flattened. Colour mixed glass arrives at the site in special bags provided to householders. There is no market for colour mixed glass in the Seattle area. Manual glass sorting (on a sorting table) begins with hand-picking of returnable beer bottles which are placed in cases and stacked on pallets. Green and brown glass for recycling are each pitched into separate compartments of a roll-off container. Clear glass is hand-fed into a crusher and conveyed into its compartment in the roll-off container. (20,21)

- F. Oxfam WasteSaver Project, Kirklees, U.K: In its fundraising effort for Third World development, this international charity has organized a source separation program in which materials delivered to a warehouse are processed "As far as limitations of capital permit." Several grades of paper are baled. Refillable, refundable, and reusable (e.g., for winemakers) glass containers are hand picked. Remaining glass is manually colour sorted with hand removal of caps and rings, and fed into a crushing mill. "Tin" cans are magnetically separated from other metals, and mechanically granulated for high density transport to a de-tinning plant. Plastics are baled in two categories, polyethylene film, and containers. Textiles are sorted for reusable clothing and six grades of rags are baled for sale to industry. Almost all of the equipment and know-how has been donated by industry. Manpower is chiefly volunteer, except for a core of paid supervisory staff. (22)

The above examples show how processing fits into different source separation system designs, and is therefore tailored to local circumstances. All processing involves machinery and transfer equipment such as drums, bins, forklifts, hand trucks, conveyors, crushers, shredders and balers.

Comparative processing cost data for the examples cited is limited. For instance, Sacramento's sorters are "free" labourers, and annual overhead related to the sorters is an estimated \$6,483 (1977 U.S. dollars), a cost that is covered by the revenue of \$15,366 at \$6.50 extra per ton sorted; however, if county employees (paid at \$10.39 per hour) were to sort the same tonnage, then labour and overhead would soar to \$49,706, a cost that would not be covered by the sorting revenue. (13) A detailed comparison of Nottingham System locations appears in Section 10. For these five locations, plant operating costs include the cost to dispose of refuse residuals and are not specified for processing only. It is instructive that the more recently implemented locations are marketing to intermediate processors and taking revenue cuts, instead of processing to the extent found in Nottingham itself. (Nottingham, which is

described in Appendix 4, was implemented before intermediate processors became active.) Specific processing costs are not available from Project Arrowhead, which is a skill-training program and does not aim to reduce high, subsidized labour costs. For San Luis Obispo, costs (see Section 12 on Economics) have not been documented in a way which allows the isolation of metal processing cost. Since the program has been carefully designed to be an attractive prototype for other private haulers, it can be assumed that the buyer which provides the metal crusher is the best market choice under given circumstances; also, processing labour is available due to slack time at the collection stage. Seattle is the only example for which specific processing cost data exist due to a sophisticated, computerized cost recording system. Seattle's processing activities, detailed in Appendix 5, come to \$39.64 per ton. Documentation on the Oxfam WasteSaver Project does not specify processing cost.

10.6 Collection Vehicle Role in Processing

An example of actual processing machinery mounted on a collection vehicle is documented in literature about a west coast yard waste shredding operation.(23) Packer trucks employed to collect recyclables result in some volume reduction of metal and glass during compaction cycles. (Although newspaper is collected in packer trucks, no significant additional volume reduction is achieved during compaction since newspaper, especially when bundled, is already quite dense.) Regardless of type of truck employed for source separate materials pickup, some glass volume reduction normally occurs through rough handling. Vehicle crews may perform upgrading in the limited sense of pulling obvious contaminants at the point of loading. Thus volume reduction is achieved by some collection vehicle types and/or crew methods, and upgrading occurs during collection through quality control by crews.

The collection vehicle in curbside programs is the link between householders and the off-load site; therefore, the design of the collection vehicle in a curbside program is interrelated to processing activities performed before or after collection. For instance, when buyer specifications dictate that glass must be colour sorted, and when no colour sorting is performed at the program site, then householders must colour separate, and the collection vehicle must have separate compartments for each colour of glass or a multiple pass system must be used. Alternatively, given the same market specification, glass colours can be mixed by the householder, kept mixed (with a minimum of breakage) on the collection vehicle, and separated at the program site. (There is no point in asking householders to colour separate if separate colours will not be kept separate on the collection vehicle.)

In some cases the collection vehicle design choice acts as a constraint by limiting options for where processing occurs in the materials flow. For example, the designer of the "Separated Discards Carrier" (a refuse collection vehicle adapted with two hydraulic loading buckets--one for cans and one for glass--plus a rack for newspaper, see Section 7) recognized that refuse collectors would balk at loading three separate compartments for glass alone, even if three glass compartments could be mounted onto a refuse vehicle. So only one glass loading bucket is mounted on the "SDC," which can collect only colour mixed glass or only one colour of glass. In Exeter, New Hampshire, where the "SDC" is being tested, there is no market for colour mixed glass; consequently, colour mixed glass is collected and colour separated at a handling facility. Since glass broken during collection proved to be difficult to colour sort, special baffles have been installed in the "SDC's" loading compartment in order to prevent breakage.(24) Program operators in Seattle, Washington (see Appendix 5) are faced with a similar market situation and do not want to inconvenience householders or slow down collection time by colour separation. In Seattle, glass is colour sorted at a handling facility, but glass breakage during collection is prevented because householders are given special bags to contain glass until the point of sorting. In the cases of both Seattle and Exeter, vehicle designs related to the collection stage necessitate processing (colour sorting) at a later stage in the materials flow.

10.7 Householder Preparation Requirements

In all source separation programs, householders are required to prepare separated material(s) for collection by following guidelines set by program operators. Some of these householder "preparation requirements" may be considered primitive forms of processing. For example, volume reduction is performed by householders when they flatten tin cans, and upgrading is performed by householders when they sort glass into colours and remove metal contaminants from glass containers.

The amount of effort required of householders depends on further stages in the materials flow; that is, the specifications of the secondary materials user dictate how materials must be prepared for eventual reprocessing, but there may be intervening stages in the materials flow between the householder and user where processing is performed, thus reducing householder preparation effort.

Designers of source separation programs set the guidelines for householder preparation requirements. Deciding on the amount of household effort is significant because of the trade-off between participation and cost-revenue. When householders are not inconvenienced by

many preparation steps, they are considered more likely to participate in source separation programs. This elimination of householder preparation requirements results in costs at further stages. For instance, labour and equipment costs will be incurred by program operators if upgrading is carried out at a collection centre site/curbside off-load site; or revenues will be lower if intermediaries (single-/multi-material dealer/processor) perform this upgrading; or lower prices for contaminated materials (if accepted) will be paid by ultimate users. On the other hand, when householders are asked to carry out more of the preparation activities, lower participation is expected, but upgrading costs are minimized for program operators, intermediaries and ultimate users. This trade-off problem varies with local market availability and types of fractions collected.

A significant trend in certain U.S. source separation programs is the relaxation of householder preparation requirements. The assumed higher participation and correspondingly higher throughput are thought to either result in economies of scale for processing done by program operators, or off-set lower unit revenues paid by buyers who perform processing.

The source separation programs examined for this report differ widely in requirements for household effort. The following points illustrate how household preparation requirements are affected by other stages in the materials flow and by particular program designs.

- A. Paper: Paper involves the least householder effort. Assuming that newspapers are relatively contaminant-free as delivered to householders, preparation requirements involve little upgrading on the part of householders in programs which collect newspaper for ultimate de-inking or reprocessing into insulation. Preparation requirements in programs which collect mixed paper involve the reverse of upgrading--the addition of other grades of paper to newsprint. Regardless of ultimate use, householders are always asked to bundle or bag newspaper in curbside programs. (This form of volume reduction bears little similarity to the mechanical sophistication or purposes of baling.) Bagging and especially bundling reduce the potential for litter from loose curbside set-outs and open collection vehicles, and enable easier manual handling of paper during collection and later stages.
- B. Glass: Householder preparation requirements for glass, i.e., washing, removing metal contaminants, and colour sorting, vary with specifications of buyers, amount of processing done by program operators, and collection constraints. Householders are

normally asked to wash/rinse glass containers in order to reduce odour problems during storage in the household and at later stages. Washing appears to be more critical when curbside collection occurs at infrequent intervals, and when glass is stored at program sites for long intervals. Removal of metal caps and neck rings in order to meet the specifications of ultimate users, is required of householders except when this form of upgrading is carried out by labour at program sites (labour costs are high), or by intermediate processors (lower revenues paid to program operators reflect processing costs). If colour sorting is specified by ultimate users, or if the market demand for colour mixed glass is not stable, then colour sorting is required of householders except when this form of upgrading is carried out by program labour or by intermediate processors. In practical terms, and assuming that two or more colours of glass are marketable, householder colour sorting entails special arrangements at the collection stage. For instance, in curbside programs, either collection vehicles have to be compartmentalized to keep glass colours separate, or the multiple pass system must be employed to collect a different colour of glass on each pass, whereas in drop-off programs, there must be separate, marked bins for each colour of glass collected. (If there is no market for a certain colour/colours of glass, then such glass becomes a contaminant which must either not be included with acceptable glass by the householder, or be removed from acceptable glass at a later stage.) If colour sorting is not specified by the ultimate user, then this form of upgrading is not required at any prior stage. Volume reduction through breaking is never required of the householder (except in drop-off programs in which patrons are allowed to pitch glass into bins).

- C. Metal: Aluminum beverage cans, food containers, and foil are rarely required to be kept separate (by householders) from "tin" cans in curbside programs because of the complications that would result for truck design and crew loading time; however, aluminum and ferrous metals sometimes must be kept separate by householders for delivery to collection centres. (Due to the much higher revenue for aluminum than for ferrous, aluminum is always manually or magnetically separated from ferrous at some stage in the materials flow in the U.S.) No programs are known to require flattening of aluminum by householders. Cleaning, label removal, and flattening requirements for "tin" cans vary as for glass. Cleaning avoids odours at collection centres, and during storage intervals in the home when pickups are less frequent. Label removal need not be done by households in programs

where "tin" cans are first incinerated (to remove labels and laquered coatings) for use by the copper mining industry. When the ultimate user is the steel industry via de-tinning plants, label removal is required. Can flattening is an asset for home storage at less frequent pickup intervals, but is usually required of householders for the purpose of saving space in curbside collection vehicles, at curbside off-load/collection centre sites, and in vehicles which haul "tin" to buyers. If packers are employed in curbside collection, if flattening is done at program sites, if the ultimate user is the copper mining industry, or if intermediaries are used, then "tin" cans are not usually required to be flattened.

Although the burden on householders in single-material newspaper recovery programs may be minimal, householders in multi-material programs may be faced with several preparation steps. In the northeast U.S. and west, in response to disposal crises, source separation is generally promoted as a normal habit that should become widespread rather than as a committed act of the concerned; consequently, there have been recent attempts to reduce the burden on the householders.

The extreme case of Downey, California, illustrates the minimal participant effort required where intermediate processing is used. Here, all recyclables (paper, colour mixed glass, aluminum, and "tin" cans) are set out for curbside collection in one bag or box. Scavenging, a widespread problem before total co-mingling was initiated, has ceased to be a problem because newspapers are no longer conveniently bundled and set out. The Sessler Company, a glass cullet dealer, separates and markets the materials. (25) In Marblehead, Massachusetts, participants are not required to wash cans or bottles, to remove any paper labels or metal rings from bottles, or to flatten cans. All flat paper, including glossy magazines and writing paper, is acceptable. There are three levels of separation for set-outs: bundled paper, clear glass/cans, and green-amber glass/cans. Matcon, Inc., an intermediate processor, buys the glass and metal, upgrades these materials (but does not colour separate the green-amber glass mixture), and re-sells to industry. A paperstock dealer adjacent to Matcon buys the mixed grade of paper. Consultants retained to evaluate this Massachusetts program have recommended that householders be asked to wash the glass and metal for odour reduction purposes. (26)

10.8 Summary and Conclusions

In this section, processing stages, activities, and purposes are examined for source separation programs in jurisdictions outside of Ontario. Processing includes material upgrading and volume reduction.

Regarding its stages, processing can occur in the household, on a curbside collection vehicle to a limited extent, at a central program site (where materials are off-loaded by individual patrons, curbside collection vehicles, or vehicles which service other collection sites), at the site of a multi-material intermediate processor (where in existence), and at the site of a conventional single-material dealer/processor.

It is found that the specifications of secondary materials users determine the need for upgrading activities at earlier stages in the materials flow. The distance of secondary materials buyers determines the need for volume reduction activities, many of which are also considered to be forms of upgrading, e.g. small, contaminant-free glass particles are more economical to ship and are also more acceptable for recycling purposes, than are whole bottles.

Processing at later stages in the materials flow reduces the need for processing at earlier stages, but important trade-offs are involved. If households are to be confronted with minimal inconvenience, then processing can either be performed at central program sites or later, by intermediaries. In-program processing is costly but brings maximum revenue from buyers of materials. Intermediate processing obviates the need for in-program processing and therefore saves source separation program costs but results in lower revenues paid to programs. Generally, in both single-material newspaper collection programs across the continent, and in multi-material programs in the U.S. northeast, source separation programs are opting for lower revenues paid by intermediary paperstock dealers and multi-material intermediate processors, in return for processing services which reduce processing activities at central program sites and at the household level. The resulting convenience to households and therefore assumed higher recovery, and the elimination of in-program processing costs, are considered to be worth the loss of maximum revenues for individual source separation programs.

"Intermediate processors" are highlighted as a significant contribution to source separation. Each of the four intermediate processors, identified by the U.S. Environmental Protection Agency, is different in terms of services provided and nature of operation (e.g. acceptance of fully comingled

paper/glass/cans, vs. acceptance of colour separated glass and mixed ferrous and aluminum cans). But, as a group, these entrepreneurial operations are able to meet the specifications of materials users, and are reducing the need for processing at earlier stages in the materials flow, and therefore are helping to sustain and increase the number of source separation programs in operation, especially in the U.S. northeast where the glass industry resists accepting unprocessed post-consumer waste glass. Generally, the intermediate processors offer the following advantages:

- Little or no material preparation is required of householders, and little or no upgrading or volume reduction need be performed by source separation programs.
- Transportation services are either provided or arranged for materials being moved from source separation program sites to processing facilities; therefore, programs can save storage space/costs and shipping costs by shipping to one buyer instead of several buyers and by shipping to closer points instead of distant points.
- Marketing services are provided for a number of source separation programs; therefore, individual programs can market all fractions to one buyer and the buyer can negotiate a higher unit price, from user industries, with the pooled volume.
- In the case of glass in the northeast U.S., the intermediate processors provide a glass market which would not otherwise exist.

In the northeast and west, processing is also carried out at source separation program sites where intermediate processors are not available, or for various reasons, not utilized. The reasons for processing include a desire to: save storage space, save hauling costs, secure markets, obtain higher revenues from materials buyers, make source separation more convenient to householders, eliminate the need for additional compartments in curbside collection vehicles, and eliminate the need for quality control by collection vehicle staff and collection centre patrons.

Nevertheless, the cost of processing small volumes of recyclables can off-set the revenues gained or savings accrued by the various labour intensive and mechanical methods cited as processing activities in this section. The lack of hard cost data for in-program processing activities inhibits an evaluation of the cost-effectiveness of processing at the central site level. Cost data supplied by intermediate processors indicate that, with capital equipment and operating costs of \$10 to \$30 per ton, their operations are at least marginally cost-effective depending on revenues achieved.

Curbside collection vehicle constraints are found to determine the need for in-program or intermediate processing under certain market conditions, because of the need to reduce segregation responsibilities of householder participants and collection staff. For example, efficient multi-material curbside collection must minimize the number of curbside set-out containers, and curbside vehicle compartments or number of curbside passes required for collection; thus, where no markets exist for colour mixed glass, it is necessary to collect glass that is colour mixed and then separate colours at a later stage in the materials flow.

Despite the fact that glass/cans intermediate processing and in-program processing techniques have advanced the state of the art in source separation elsewhere, these experiences have limited applicability for Ontario. Most processing elsewhere is in response to:

- the resistance of the glass industry toward accepting glass that is not in kiln-ready particles or colour separated;
- the prevalence of aluminum beverage cans in the residential waste stream and the high revenue associated with aluminum cans when separated from ferrous metal;
- the heavy concentration of multi-material source separation programs on the east and west coasts where public enthusiasm for "recycling" and public recognition of the waste disposal crisis prevail;
- the tradition of comingling (glass/cans or paper/glass/cans) that has been established in certain regions.

Few source separation programs, and only one out of four of the intermediate processors, in the U.S. bale fibres, due to vigorous conventional dealer activity in supplying the newspaper recycling industry and export market.

In Ontario, the need for glass upgrading may not be necessary if glass manufacturers pursue plans for a glass beneficiation plant and pay fair prices for colour mixed, metal-contaminated glass. Here, the need for ferrous-aluminum separation is not relevant, due to legislation proscribing aluminum beverage containers. Here, waste residential material recovery does not yet enjoy equal priority status with conventional refuse disposal. In Ontario, comingling of several materials has no precedent in multi-material collection programs (few multi-material curbside programs exist). These domestic factors mitigate the applicability of U.S. in-program and intermediate processing experiences.

Nevertheless, the concept of the intermediate processing facility could be applied, with appropriate modifications, to the Ontario situation. Volume

reduction of glass and "tin" cans at regional processing facilities, fed by individual source separation programs, could make a contribution to economical, bulk shipping of materials. It may be advisable for Ontario source separation programs, through regional facilities, to gear up for fibre baling in order to supply distant paper mills in addition to local cellulosic insulation manufacturers whose demand currently fluctuates seasonally and whose demand may greatly slacken in future.

As an implemented concept, the intermediate processing facility could therefore help Ontario source separation programs to meet user industry specifications and could contribute to storage/shipping economies--both through technical "hardware" means. Also, the concept could be applied to the provision of legal, accounting, education, marketing, and other "software" services currently carried out and duplicated by individual programs in various Ontario regions. Regionalization of services is also discussed in section 8. Further research should be undertaken on regional processing facilities appropriate for Ontario.

SECTION 11

PARTICIPATION IN SOURCE SEPARATION PROGRAMS11.1 Introduction

Motivating public participation is the major challenge facing source separation program sponsors. Low participation is a problem that must be solved if source separation is to take its place among effective waste management options amidst criticism from mechanical recovery proponents. This section looks at the variables that affect participation: community characteristics, source separation system design factors and publicity strategies. The state of the art for predicting and ensuring participation is not highly advanced. It is first necessary to deal with a semantic and measurement problem that is found in the literature.

11.1.1 Definition of Rates

Participation rate, strictly defined, is the number of households setting out recyclables in a curbside program or using a drop-off centre, as a percentage of the total households in a program area. To measure participation with accuracy requires repeated monitoring of set-outs or drop-offs. This monitoring is a luxury that most programs cannot afford due to lack of time and funds.

In addition to "participation rate", another expression of source separation program effectiveness, is "recovery rate". It is sometimes considered to be the ratio of recyclables collected (recovered) to potentially available recyclables. Such estimates are deduced from newspaper circulation figures and from local data on recyclable waste generation and composition. "Recovery rate" is also used to denote the percentage of waste diverted from total residential refuse, including non-recyclable waste, as a result of source separation activity. This second meaning of recovery rate would be more accurately termed "diverted disposal rate". Such estimates are deduced from total residential waste generation data.

Recovery rates (first meaning) are useful for showing how much of the recyclable potential is being tapped. Diverted disposal rates are useful for showing what kind of "dent" source separation is making in refuse disposal. The diverted disposal rate is the key indicator of program success from the waste management point of view; however, without public participation, there is neither recovery nor diverted disposal. Thus the emphasis of this section is on participation.

As participation rate, recovery rate and diverted disposal rate are used interchangeably in the literature

about source separation, it is difficult to compare source separation programs. Each measure has its usefulness but there is not necessarily a correlation among the three measures. An attempt will be made to point out which measure is being used as a proxy for participation rate when the distinction is relevant in this section. (The single word "recovery" will be used in the following discussion as a synonym for amounts collected through source separation.)

$$\begin{array}{lcl} \text{Participation Rate} & = & \frac{\text{Number of Participating Households}}{\text{Total Number of Households Included in Program}} \times 100 \\ \text{(for each fraction} & & \\ \text{or for all fractions)} & & \end{array}$$

$$\begin{array}{lcl} \text{Recovery Rate} & = & \frac{\text{Total Recovered Tonnage}}{\text{Total Tonnage Available for Recovery}} \times 100 \\ \text{(for each fraction)} & & \end{array}$$

$$\begin{array}{lcl} \text{Diverted Disposal} & = & \frac{\text{Total Recovered Tonnage}}{\text{Total Residential Refuse Tonnage}} \times 100 \\ \text{Rate} & & \end{array}$$

11.1.2 Variables Summarized

Following is a list of factors which will be discussed for their relationship to participation in source separation programs.

Community Characteristics:

- Socioeconomic status (SES)
- Existence of ecology groups
- Stage in family life cycle and family size
- Community size
- Disposal as an issue

Source Separation System Design Factors:

- Program duration
- Curbside collection frequency
- Separate collection related to refuse collection
- Simultaneity of collection in multi-material programs
- Use of the rehabilitation labour pool
- Reliability of service
- Preparation requirements
- Fractions collected
- Type of program
- Mandatory separation
- Financial incentives

Publicity:

- Publicity program planning considerations
- Specific publicity tactics
- Ongoing publicity

This section concludes with summaries of available case studies and quantitative research on publicity and public participation in source separation programs.

11.2 Community Characteristics Affecting Participation

A. Socioeconomic Status:

In an early engineering study of U.S. separate curbside collection programs, participation is found to be a function of SES. Using a qualitative assessment of the SES of twenty-two communities, authors show that participation increases from middle to upper middle class communities. These results are backed up by a university study of depot users and non-users in Madison, Wisconsin. Depot use increases with family income, professional status of the family head and educational level of family adults.(1)

While other factors help to account for the differences in the percent of residential waste recovered (diverted disposal) in Somerville and Marblehead, SES is a significant variable as shown in the following table:(2)

Table 14: Program Success as a Function of SES in Somerville and Marblehead

Characteristics (1977)	Somerville	Marblehead
Median Annual Income	\$ 9,600	\$ 12,600
Median Years of Education	11.6	13.2
Housing Type: Single Family	10%	70%
Multi-Family	90%	30%
Ownership	35%	85%
Rental	65%	15%
Diverted Disposal (called recovery in consulting reports)	8.1%	24.4%

A report on a questionnaire survey in San Luis Obispo, California finds that participation claims are made most frequently by those who rank themselves as "professionals" and "foremen", with lowest participation among "equipment operators" and "labourers". To complement this subjective data, collection beat set-out monitoring is plotted with income levels from neighbourhood blocks. Middle to high income blocks (over \$8000 per year) exhibited the highest participation. Three lower income blocks (under \$5000 per year) have higher participation

than middle income blocks (\$5000-\$8000) but this is attributed to high university student occupancy. The fourth low income block without a student population has the lowest participation rate.(3)

Indications are that source separation programs in high SES areas will result in more public participation, recovered recyclables and diverted disposal. Such areas are also associated with higher newspaper circulation, a factor to be taken into account especially when choosing areas for source separate newspaper collections.

B. Existence of Ecology Groups:

As a motivational impetus, ecology and public interest groups have always played an important role in advocating source separation programs. Many of these groups operate their own source separation projects, or help to carry out initial and ongoing publicity and education in programs sponsored by government and business. In some areas, where the debate rages over mechanical recovery vs. source separation, ecology groups have tipped the balance toward the latter. The expression "eye wash program" refers to uneconomical source separation programs that are continued by municipal and private sponsors in order to mollify ecologists. There are indications that ecology group pressure is less necessary (in the late seventies as opposed to earlier times) for source separation program implementation. Many U.S. municipal and private haulers are turning to source separation, in order to conserve disposal budgets and sites, and in order to comply with strong environmental disposal legislation. Where paper markets are reliable, program sponsors can even expect to make a profit. Industries are increasing their use of post-consumer waste in order to save on materials, energy, maintenance and pollution costs. Many volunteer ecology groups have evolved into non-profit source separation companies which resemble businesses. Some groups have turned their recycling projects over to municipalities and private haulers. (While the motives for starting and maintaining source separation programs are varied, ecological purposes are nearly always cited in program promotion.)

C. Stage in Family Life Cycle and Family Size:

That participation in source separation programs is higher among younger and larger families has not been substantiated where hypothesized. The Madison study cited above finds that depot use is related neither to the number of children under eighteen in families, nor to the age of the family head.(4) A San Luis Obispo door-to-door survey shows that age and size of family does not have a significant effect on participation.(5) (The enquiry was to be an indicator of the effectiveness of publicity efforts directed at school children.) In Fullerton, California, city areas high in senior citizen population have high participation but low recovery of newspaper. This indicates that people

on fixed incomes or pensions may not subscribe to daily papers in the same proportion as other age categories.(6) In contrast, Florida communities with disproportionate senior citizen populations, have high newspaper recovery rates. This is due to heavy subscribership to newspapers from "back home" and investment journals, a function more of SES, than lifecycle stage.(7)

D. Community Size:

Indications are that source separation is most effective in diverting disposal amounts in smaller communities. This is partly due to lower quantities of waste and an eagerness to reduce higher per capita disposal costs, but it is also related to the effectiveness of publicity, especially word-of-mouth techniques in smaller, more homogeneous communities. A 1974 U.S. study of collection centres finds that the diverted disposal rate decreases with a rise in population among communities with collection centres.(8)

E. Disposal as an Issue:

Communities may be faced with loss of traditional disposal options or skyrocketing costs of new regional facilities. In such places political decision-makers are more supportive of source separation. The crisis facilitates citizen participation in source separation as a result of increased publicity and public concern about the waste issue.

11.3 Source Separation System Design Factors Affecting Participation

A. Program Duration:

While quantitative data are scarce, an early study of twenty-two separate collection locations finds that participation is related to program duration. (Expected increases in participation of 18% per year are projected for the study areas.)(9) An interesting contradiction of this trend is shown in the annual tonnage figures for the City of El Paso, Texas. Collected newspaper tonnages (no rates available) have steadily declined since program inception in 1974, yet revenues are generally the same. City officials attribute "low participation" to the voluntary nature of the program and plan to increase publicity.(10) Despite the many differences between Somerville and Marblehead, the higher recovered amounts in Marblehead are at least partly attributable to its source separate collection going back to 1972.

B. Curbside Collection Frequency:

It is desirable to know the relationship between participation and frequency of collection because a trade-off is involved. Frequent collections are costly but are thought to be essential to high participation. Less frequent collections save on costs but may depress participation due to storage problems in the household.

The question becomes: At what point in lowering frequency of collection, does participation decrease?

In an early study of seventeen separate truck programs, frequency of paper collections does not correlate with participation rate. Several bi-weekly and monthly programs have greater participation rates than weekly programs. One case study location contradicts this finding if looked at independently. Forth Worth, Texas, operates a pickup program with two different collection frequencies with all other variables equal. Participation in the weekly areas is 40%, while bi-weekly areas average a participation rate of 25%.

In the above study, diverted disposal quantities are related to collection frequency. Weekly programs divert disposal amounts by an average of over 7%. Bi-weekly programs divert 6% and monthly programs only 3%. Thus diverted disposal quantities increase as collection frequency increases. This trend is reinforced by data from the Fort Worth pilot area. In the weekly collection area, participants put out an average of 21 pounds of mixed paper. In contrast, participants in the bi-weekly collection area, place out 30.6 pounds of paper, an average of only 15.3 pounds per week. The authors of the above study conclude that while collection frequency does not affect participation, more frequent collection results in increased diverted disposal quantities.(11)

In San Luis Obispo, weekly collection of recyclables is carried out because a full time crew has been hired for separate collection. (If bi-weekly collection were performed, there would be difficulty in finding other jobs for these men or in finding men willing to work part-time.) Participation data were collected by monitoring set-outs from 180 households over thirteen weeks in order to see if weekly collection is really necessary. As reported by authors, overall participation (set-out) frequency averages once every four weeks to bi-weekly. Among "regular" participants (those who participated once a month for the three study months) participation averages every other week. Only 29% of the households participated for more than six weeks and no household participated for more than ten weeks. Only ninety or half the homes participated for two to five weeks out of thirteen weeks.

With participation averaging once every three weeks, authors conclude that weekly collections could have been cut back to bi-weekly or tri-weekly. Their recommendation to larger cities is that more homes can be serviced with the same collection equipment and crew with bi-weekly instead weekly collections. If bi-weekly collection is established at the beginning of such a program, neither participation rate nor diverted disposal quantities would be affected. However monthly collections are not recommended.

Most households in San Luis Obispo find it necessary to set recyclables out at least every three weeks. Therefore monthly collection could reduce collected amounts due to storage problems in the household.(12)

In order to determine the collection frequency most conducive to participation in Somerville and Marblehead, consultants examined results of attitudinal surveys carried out prior to program implementation. According to report authors, most residents prefer weekly collection of cans and glass and three quarters want newspaper collection either weekly or bi-weekly. In Marblehead, there had been a monthly source separate collection with each fraction picked up during a different week (multiple pass system). 44% of the residents cite problems with the past system such as storage space limits, infrequent collection and confusion over schedules. Late 1976 phone and personal interviews were carried out with the finding that 55% of Somerville residents and 72% of Marblehead residents claim to set out recyclables weekly. Only 14% and 18% respectively claim to set out less than weekly.

As a result of these surveys, a weekly collection frequency has been implemented requiring that collection trucks serve a large number of homes per day. But the trucks do not work to capacity because each stop has a set-out of only one week's worth of recyclables and not all residents participate. The consultants conclude that participation would decline slightly with a bi-weekly pickup but less frequent collection would be more cost-effective. They state that collection frequency is very difficult to determine.(13)

C. Separate Collection Related to Refuse Collection: It is often assumed that householder convenience is correlated with participation in source separation. One way to minimize inconvenience is to collect recyclables in the same vehicle as refuse or to collect recyclables on the same day as normal trash. In neither case do residents have to remember schedules for their pickup day. The only inconvenience is the need to containerize recyclables separately from refuse.

No quantitative data were found to substantiate this hypothesis. It is possible to extrapolate from a study where rack systems (simultaneous collection of refuse and newspaper) are compared with separate truck systems (collection of recyclables on bulk, brush or "white goods" days, different from normal refuse collection days). The seventeen separate truck case histories have an average diverted disposal rate of 6% by weight. In contrast, the four rack locations have a 3.2% diverted disposal average. The estimated average participation rates of these two systems are 39% for separate trucks and 21% for racks.

The authors of the above study claim that participation and diverted disposal should be much higher for the rack approach because pickups are frequent and schedules are not confusing. The low success of three of the rack systems is attributed to poor publicity and attempted revival of one program that had been cancelled because of marketing problems. On the basis of this limited data, participation does not appear to be boosted by same day/simultaneous collection of recyclables and refuse(14) but many source separation proponents back the practice.

A recent evaluation of the most successful multi-materials source separation program in the U.S. deals with this question. In Marblehead, Massachusetts recyclables were initially collected on refuse collection days. The program was plagued with collection crew confusion over whether curbside containers held recyclables or refuse. Stopping to check for recyclables took up valuable collection crew time. The collection of recyclables now takes place on a different day from refuse collection--the day made available for recyclables collection as a result of dropping the second weekly refuse collection day, a saving partly attributable to source separate diverted disposal quantities. Consultants retained to evaluate Marblehead's program recommend against same day collection of refuse and recyclables. The main reason for the recommendation is to increase collection productivity. The consultants also hypothesize that the visibility of recyclables on a separate collection day will provide a neighbourhood inducement to those who do not recycle.(15)

D. Simultaneity of Collection in Multi-Material Programs: The newest and most sophisticated U.S. multi-material source separation programs are designed for simultaneous collection of all recyclable fractions. The rationale is to eliminate householder confusion over collection schedules. Container trains and compartmentalized vehicles are necessary for this kind of collection unless intermediate processing allows total comingling of metal, glass and newspaper in a single truck. These new programs are an alternative to the multiple pass system for collection of several fractions, each on a different day in a non-compartmentalized truck. The latter system requires that householders remember which fraction is collected on which day of the week/month.

Unquantifiable indications are that non-simultaneous collection of recyclable fractions is less conducive to high participation. Early engineering studies, often cited in this report, do not compare these two options because compartmentalized vehicles were not in use in 1974; however, Marblehead offers a case in point. The present system (simultaneous) has doubled the diverted disposal rate of a previous multiple pass system; but the newer system was also introduced with heightened publicity, easier householder preparation requirements and better overall collection service.(16)

Proponents of the multiple pass system cite advantages of direct transport of materials to local markets, better collection efficiency and use of surplus standard collection vehicles--all traded off against the household inconvenience and memory factor.

E. Use of the Rehabilitation Labour Pool:

Although there are no comparative data, high participation rates are claimed by organizations which couple reclamation and social rehabilitation goals. For instance, a Black skill-building source separation program run by the U.S. National Black Veterans Organization boasts a tenant participation rate of 50%-80% per low income building in Washington, D.C.(17) A youth employment source separation program run by Residents' Recycling claims a 50% diverted disposal rate in Cambridge Housing Authority buildings in Cambridge, Mass.(18) Arcata Community Recycling Center in California claims its co-operation with the county legal system in rehabilitating parolees and probationers is an encouragement for participation. There is no participation data for Arcata's small town/rural drop-off operation but staff estimate a 16% diversion of local refuse. The pure ecological motivation would not be welcome in this lumber-based area.(19) A Native persons skill-building newspaper collection program called WeatherCheck claims 90% participation from subscribers to the Winnipeg daily newspaper.(20) In each of the above four cases and in many others, social problem groups form part of the source separation program labour force and add to the perceived local benefits of participating in source separation.

F. Reliability of Service:

There is wide recognition that a source separation program must give consistently reliable service, otherwise participation will drop off and publicity efforts will be eroded.

Labour problems causing temporary curtailment of service have depressed participation as documented in Somerville, Massachusetts and Palos Verdes Peninsula, California case histories. The same studies report that crew disillusionment with new working conditions can affect program credibility.(21)(22)

Loading practices for recyclables have contributed to public confusion and lower participation. In Marblehead where glass is colour sorted into clear and green/brown, early problems with compartmentalized collection truck design resulted in some glass mixing during bucket loading; therefore collection crews removed a partition that kept colour sorted glass separate and when residents witnessed this, many stopped further colour sorting. Demonstration grant terms were quickly reinstated to force replacement of vehicle colour sorting partitions.(23)

Low participation in some newspaper rack programs is sometimes attributable to the compacting of paper with normal refuse when racks fill. Public disillusionment results in lower participation.

Weather problems are associated with temporary participation decreases as separate collection cannot be carried out in east coast snow storms or west coast heavy rain periods. But if participants do not receive explicit instructions that collections will not take place in severe weather, then the temporary curtailment of collection may result in permanent loss of participation. Public confusion over weather has been well documented in Somerville.(24)

Public disillusionment resulting from equipment problems has occurred: When there is temporary suspension of separate collections during equipment down-time for repairs; when conventional refuse vehicles are substituted for the usual recycling vehicle undergoing repair; and when packer trucks are used for separate collection amidst expectations of a special vehicle at program initiation.

When market slumps force the stoppage of collection, it is difficult to revive public participation if collection is reinstated. Private hauler source separation programs are more prone to this problem because subsidized municipal and volunteer programs can tolerate lower revenues or can stockpile. Commercially-run source separation programs which start and stop according to market trends are injurious to participation.

G. Preparation Requirements:

Another way to minimize householder inconvenience is to eliminate preparation requirements for recyclables. There is a trade-off between less household effort and either lower market revenues or need for further upgrading. (This trade-off is discussed in detail in Section 10.) In areas of the U.S. where there are intermediate processors or dealers which process a fraction, the trend in source separation programs is to trade lower revenues for higher participation. The higher throughput of recyclables collected is considered to justify lower revenues per ton.

Ease of preparation alone does not guarantee high waste diversion rates as illustrated by another comparison of Somerville and Marblehead. In Somerville colour mixed glass/cans were collected, whereas residents of Marblehead must separate flint glass/cans from green-brown glass/cans. Yet in Somerville where preparation was more simple, the diverted disposal rate was only 8% compared to Marblehead's rate of 24%. Several other variables help to account for this difference: SES program duration, and collection reliability. Before program collapse, ease of preparation was still viewed as critical in sustaining Somerville's (low) participation rate. When the colour mixed glass market collapsed in New England, officials did not ask residents of Somerville to

begin sorting into flint and green/brown glass. Instead, green/brown glass was dropped from the program.(25)

One possible problem with easy home preparation requirements is an increase in contamination, especially ceramics in glass set-outs. This problem has been identified by the U.S. EPA as a result of Somerville and Marblehead pilot programs. If home preparation (colour sorting, cap and ring removal) is more demanding, homeowners may be more careful to eliminate ceramics, than if unwashed, unsorted glass bottles ("anything goes") are allowed. It would be useful if data were available that compared contamination as a function of preparation requirements when all other determining variables are held constant, especially educational publicity.

H. Fractions Collected:

Early U.S. case history data indicate that newspaper source separate collections have higher participation rates than multi-material programs, 42% and 29% respectively. This is attributed to ease of household preparation. Conversely multi-material collections have higher disposal diversion rates than newspaper programs, 10% and 6% respectively.(26) In a significant multi-material program, participation is higher for paper than for either glass or cans. In San Luis Obispo both set-out sampling and personal surveys, indicate that newspaper is set out more often than cans and glass. Report authors also conclude that, "Three category separation does not significantly impact on participation". This conclusion contradicts the first point above.(27) In Marblehead, another significant multi-material program, participation frequencies for set-outs are lower for newspaper than for glass/cans, 21% and 30% respectively; but combined set-outs (paper, glass/cans) are more frequent (49%) than either single fraction set-out. In Somerville, the descending order of set-out frequencies was paper (38%), cans/glass (34%) and combined (28%). Consultants conclude that high frequency combined set-outs are attributable to program duration in Marblehead.(28)

I. Type of Program:

Comparing data from two U.S. 1974 engineering studies, curbside programs have higher participation rates than drop-off centres. Average participation for curbside programs is 29%. These include eight separate truck newspaper-only programs, five separate truck mixed paper-only programs, four separate truck glass/metal programs (two of which include mixed paper and two of which include newspaper) and five rack (newspaper) programs.(29) The average participation rate for seven drop-off centres in a sister study is 15%.(30) Diverted disposal rates for curbside and drop-off programs are 5% and 3% respectively.

In a 1976 article by the U.S., EPA, "thousands" of collection centres are compared to "hundreds" of curbside collection programs that have been implemented in the U.S.

since the 1960's. The centres average a 1% diverted disposal rate, despite some notable exceptions. Curbside programs divert 4%-9% of community waste, but are mainly limited to newspaper collection. Assuming that curbside programs are more convenient, and therefore more conducive to participation, the EPA subsequently embarked on the notable Somerville and Marblehead pilot programs for multi-material source separation.(31) In larger communities, the current state of thinking is that collection centres are transitional to curbside collections. But in rural areas where low throughputs cannot support curbside programs, collection centres are seen as viable.

J. Mandatory Separation Laws:

As concluded in Section 13 of this report, mandatory separation alone does not guarantee a successful program. In an early U.S. engineering study, cited in Section 10, participation rate and diverted disposal rate are not correlated with obligatory separation.(32) The official position of the U.S. EPA is to recommend mandatory separation under three conditions: adequate publicity, assured markets and reliable collection. The absence of any of these conditions will undermine the psychological impact of a mandatory bylaw proposed to boost participation.(33)

K. Financial Incentives:

Citing financial savings and profits attributable to source separation for local towns/cities, is a frequent pitch used to motivate participation. Similarly when soaring disposal costs become a public issue, participation in source separation is likely to increase in certain communities, as documented for Marblehead and for small New England towns adopting the Nottingham System. But only one example of rebates for householders participating in source separation was found. In Sacajawea, Washington, refunds of \$.50 per month returned to participating households, are not judged as effective in increasing participation. One significant source separation program is testing the effect of disposal penalties on source separation participation and disposal diversion in Seattle, Washington. Following are listed the three Seattle test groups and hypothesized results:(34)

Table 15: Financial Incentive Test Groups in Seattle

Program Group	Expected Result
No. 1: Charge for refuse collection according to number of containers used by household (mandatory).	Increased rates for additional refuse containers will stimulate use of local drop-off centres for recyclables. Diverted disposal may be higher than No. 2 because of the penalty, but lower than No. 3 because of the inconvenience of using depots; penalty may result in waste reduction rather than depot use.

Table 15 (continued)

No. 2: Source separate truck curbside collection of sorted glass, metal and newspaper (voluntary).	Use of local drop-off centres is no longer relevant. Participation in source separation is expected to be lower than in both No. 3 and No. 1 because of absence of penalty. Least disposal diversion is expected.
No. 3: Charge for refuse containers (mandatory) and availability of source separate curbside collection (voluntary) - a combination of No. 1 and No. 2.	Participation in separate collection and diverted disposal will be higher than in No. 1 and No. 2 because of combined refuse penalty and convenient recyclables pickup.

11.4 Publicity

Effective publicity, initial and ongoing, is recognized as essential for a successful source separation program. Before outlining publicity techniques, it is important to summarize the conditions (discussed in 11.2 and 11.3) under which any publicity will be more effective:

- High SES: better responsiveness to issues; less concern about concrete personal benefit; higher subscribership to newspapers.
- Small community size: more effective communication channels in general except for dormitory suburbs.
- Disposal crisis: more concern for reclamation alternatives.
- Other goals added to conservation: perception of increased benefits where rehabilitation labour pool used.
- Programs of longer duration: more familiarity with concept except where counteracted by temporary suspensions of previous programs.
- Convenience: less inconvenience where easy preparation of materials, frequent collections, well-placed drop-off points, easy-to-remember collection schedules; (same day collection of refuse and recyclables, a supposed but unproven convenience factor).
- Reliability of service: less disillusionment where markets stable, labour problems minimal, weather dry/mild, drop-off centre operation and curbside service consistent with information received.

11.4.1 Publicity Program Planning Considerations

Aside from specific promotional tactics, general publicity planning considerations have implications for higher participation.

A. Staffing:

Publicity is carried out by appointed municipal officials who have other duties, by public interest groups, by hired public relations consultants, by citizen advisory committees, or by all of these in combination regardless of whether the source separation program has government, business or volunteer group sponsorship. If publicity is carried out mainly by officials from higher government levels, or by hired experts, it is considered important to include some local volunteers or hires who are familiar with local institutions.

B. Expenses:

The hiring of public relations experts is the most costly route. Other modes of staffing bear lower manpower costs either because costs are not allocated to source separation or are not assigned opportunity costs (as in the case of volunteer groups, citizen committees). Costs can be greatly lowered by donations in goods and services, for instance: piggy-backed utility bill mailings, logo contests, public service media time, service club leafleting, lowered printing rates from local business, donated prizes for contests, and so forth. Soliciting donations of services and goods from businesses is, in itself, a public relations tool, for program promotion. Limited data on publicity costs are available and are listed below in specific examples.

C. Timing:

In significant new source separation programs, publicity precedes the implementation date of the program. Press and media buildups are related to slogan/logo contests and to the local decision-making process. Mass mailings, leafletings, calendar/sticker provision, usually precede startup day by one week to ten days so that participants can store recyclables in advance of the program. After startup, continuous publicity is used to encourage participation. Data from San Luis Obispo show that publicity blitzes result in only temporary surges in participation. Source separation program startup dates in fall and spring are preferred in northern climates so that weather-related collection problems do not counteract publicity efforts.

D. The Pitch:

Program themes and goals are geared to the specific community. While resource, environmental and energy conservation are always cited to motivate participation, greater emphasis is sometimes put on other goals: monetary savings or revenues, improved services where programs already exist, community pride, the necessity to source

separate where other disposal options are scarce or expensive, social advantages related to the labour force where it is a special group such as boy scouts, native people, delinquent youth or handicapped persons. It is thought that segments of the community that are not responsive to ecological concerns can be motivated if source separation "profits" are publicized as helping to pay for specific community improvements. One pitch that backfired was the promise for tax cuts for householders in Somerville; savings to the community may have resulted from source separation but taxes went up for other reasons. Questionnaire surveys are sometimes used by source separation sponsors and their agents in order to choose effective pitches.

E. Information Form and Content: Graphic designs are developed for easy program identification and to inject the community with program presence. Citizen involvement in slogan/logo contests are part of the publicity and participation buildup prior to implementation. It is known that very explicit instructions must be given for exactly how to prepare what recyclables and exactly when they are to be picked up or dropped off. This must include the conditions under which the program will not be operative, i.e. holidays, bad weather for curbside collections. After program startup, information is publicized to alert people to changes in the system, to remind them to participate, to update them on quantities recovered and to warn about contamination problems.

F. Approaches to Different Audiences: The distinction is usually made between mass publicity, and efforts geared to "gatekeepers". Key academic, club, business and civic persons are approached before and after program startup in order to gain endorsement and access to other publics.

G. Measurement of Effectiveness: Along with helping to determine what pitches suit a given community, surveys are used before program startup to pinpoint the most effective publicity techniques. Surveys are valuable when advertising budgets are low. If limited publicity funds are available, the best use of funds can be determined through use of questionnaires. Before/after, or after-only personal or mail surveys and questionnaires have four purposes: to identify what publicity techniques should be used and repeated on the basis of effectiveness; to educate non-participants or increase the participation of participants once the program has started; to pinpoint problems with the system; and to acquire newsworthy data for press/media. Repeated set-out monitoring is sometimes used to validate subjective survey response data, or to determine the changes in participation rates following the use of specific publicity tactics. This monitoring is expensive to carry out if additional paid labour is used, and can be an irritation to collection crews responsible for monitoring while on routes.

11.4.2 Specific Publicity Tactics

Publicity for source separation programs ranges from simple leafleting by public works departments to professionally planned and executed multi-faceted campaigns. The following discussion of tactics reflects the maximum effort based on an overview of existing programs and implementation guides. It would be unlikely for any one program to use all tactics listed below.

A. Slogan, Logo and Program Title:

These serve as ongoing program reminders when they reappear on collection vehicles, posters, public service ads, leaflets, letters, billboards, banners and news articles. They are developed early in the program and through public involvement in contests. Advertising the contest and publicizing the judging of results are effective publicity events.

B. Newspapers:

Local newspapers are used as a five-fold vehicle: news coverage, editorials, regular columns, feature articles and small reminder boxes (fillers). (If the source separation program includes newspaper as a collectable fraction, use of newspapers for publicity is obvious and publishers can be approached on the basis of their responsibility to help keep paper out of disposal sites.) Some programs periodically purchase advertising space as a public relations inducement for the paper to continue program coverage. Paid ads also allow a more value-loaded message than "objective" news.

Effective use of press calls for cultivation of both editorial and reporting staff contacts well before program startup. Publicity organizers research the following points in order to effectively use newspapers:

- Whether regional papers feature columns or inserts for outlying communities (it is useful to know this when the source separation program area has a large subscribership to papers published outside the community)
- Type of news or feature articles desired by publishers
- Copy deadlines, especially for weekly papers

Indications are that newspaper articles should coincide with other publicity measures such as mass mailings and should be intensive from two months before, to two months after, program startup. A news conference to kick off a source separation program is considered standard. Articles about the collection crew are used to boost the status and morale of collectors. Some problems have been experienced in cities where residents outside pilot areas have expected separate pickups after reading about source separation programs elsewhere. Effectiveness of newspaper use depends on SES, as certain income groups subscribe less to papers.

C. Radio and Television:

These media are used as three-fold vehicles: news coverage, public affairs programs/talk shows, and public service announcements. Contacts are made with assignment editors, reporters and program researchers/producers, since policies and procedures differ with each station. Radio and TV are less useful for publicity buildup before program startup because of staff reluctance to publicize future events. TV may not be as applicable as radio in small communities serviced by distant regional TV networks. Cable TV may allow production of a program or series related to the source separation scheme but viewership may not be high.

D. Community Letter or Leaflet:

A personalized letter to every householder involved in a curbside program or in a depot catchment area is thought to be more effective than a door-to-door leaflet drop. Guidelines for such a letter are:

- Brevity and simplicity of message
- Detailed instructions on the what, when, how and why of the program
- Signature by important municipal and business officials endorsing the program
- Distribution ten days to two weeks before program startup
- Envelope design with no resemblance to junk mail. It should be sealed and, where possible, addressed to the individual householder
- Volunteer distribution saves money and involves other community groups. Donated printing saves dollars and involves businesses in good will
- Simultaneous newspaper blitz

Alternatives or additional techniques are leaflets, door-to-door canvasses, surveys, open letters in the newspaper, and notices in utility bills. It is felt that printed information should be on post-consumer waste recycled paper, and should be well designed while looking purposely modest, both criteria for a form consistent with the conservation content. Another variation on leaflets, usually after program startup, is the distribution of doorhangers or mail slot inserts by collection workers to alert certain households to improperly prepared recyclables. Alternatively stickers may be affixed to uncollected materials with the reason for rejection ticked off by crews.

E. Poster:

Posters are designed for display in commercial and institutional areas. The process of distributing posters to schools, libraries, places of employment and stores, provides an opportunity to publicize the program to key persons in charge, as well as numbers of people using/passing these premises. Posters are designed to be simple, visually catchy, large, and to focus on one aspect.

of the program for maximum effect. Posted no earlier than one week before program startup, posters can be left on display for as long as possible. Limited data suggest that posters are not cited by surveyed residents as an effective publicity mechanism; but posters may be operating less consciously, as reminders, than people think, and posters may be reinforcing information received through other media.

F. Display:

Exhibits are designed for more detailed visual and printed information about the program. They are set up in banks, shopping malls, schools, libraries, civic centres and at special events. More sophisticated and expensive versions include audiovisual presentations.

G. Sticker:

Stickers are designed to mark reusable containers used for setting recyclables at curbside. They have several functions: as an advertisement about the program to the recipient of the sticker; as an advertisement about the program to passers-by who view the sticker on a container set at curbside; as an identifying marker for collection crews especially useful when refuse and recyclables are collected on the same day; and as an involvement strategy at the distribution stage, i.e. when community groups help to distribute them or when they are piggy-backed in commercial mailings. It is felt that stickers should be bright, with printed instructions that they are not bumper stickers, and be distributed shortly before/after startup day. They are not always effective as container markers for recyclables set-outs if citizens are not consistent in their use of containers; thus separate collection crews must still inspect several containers in order to find recyclables.

H. Calendar:

Calendars are distributed to participants as reminders of separate collection dates when collections are not weekly. This is an expensive technique unless the calendar can be funded (printing, paper, design, distribution) through advertising or commercial good will, or unless the calendar has always been provided as a municipal index of events. Despite Somerville's weekly collection, calendars were distributed there to link the reclamation program to local landmarks rather than to remind participants.

I. Approaches to Institutions and Gatekeepers:

School Programs: There are two reasons for undertaking school programs. One is the hope that publicity performed in schools will be brought back to the home. Another is the long-term educational effect of including source

separation lessons in school curricula. After initial approaches to school boards and principals, this component may include holding teacher workshops, giving presentations in the classrooms, providing packages for ongoing curricula and projects, using school children as a vehicle for taking leaflets home and starting an in-school reclamation program for paper generated on the premises/for materials brought from home or a combination of these.

Merchants: As implied earlier, approaches to the business community are useful for donations of goods and services which include printing, space for erection of posters, advice on hauling practices, awards for contests, endorsement, equipment, vehicles and advertising.

Community Groups: Local governing bodies, clubs, ratepayers, churches, business associations, scouts, and youth/senior citizen/women's groups are approached for several reasons: to use their existing bulletins and newsletters for publicity, to recruit their memberships for active work (leafleting, volunteer collection/depot assistance), and to gain their nominal support or endorsement. In the extreme, these groups are approached to fully operate a program started under another sponsorship. Regardless of their contribution, community group involvement is seen as vital to ongoing participation in source separation. All approaches include preliminary contact with leaders and presentations to membership meetings. These presentations include short audiovisual demonstrations, handout literature and sometimes complete packages about the program. It is thought that well-designed, brief presentations carried out by persons with good public relations skills and knowledge of all aspects of program rationale are necessary, especially for municipal councillors and business associations, since enthusiasm for alternatives, especially unproven or costly source separation programs, is not equally shared by all segments of the public.

J. Other Tactics:

Creative ingenuity is unlimited for source separation program publicity:

- A ball of twine distributed with information flyers or a special kraft bag with printed instructions and logo dropped door-to-door a week before the first newspaper collection
- Volunteers equipped with route maps and instructions recruited for door-to-door distributions

- Logo and slogan-bearing T-shirts, bumper stickers, crests and buttons used to flood the community
- Signs posted at town entrances or banners flown on Main Street to denote program existence
- Awards given to individuals who donate work
- Special containers for recyclables provided or sold to participating householders (Container functions, designs and merits are discussed in detail in Section 14.)

K. Front-Line Worker Motivation:

In municipal and commercial hauler source separation programs, and in non-profit or volunteer programs where collection crews or attendants at collection centres are funded through job-creation grants, front-line workers may not be born ecologists and may resent new work responsibilities in source separation programs. Yet these workers are in direct contact with residents and their actions and attitudes are witnessed by participating householders. A recommendation arising from experiences with collection workers in Somerville, Marblehead and Portland is that training of crews should emphasize familiarity with background, objectives and benefits of source separation programs, as well as a morale-building emphasis about worker importance to program success.

11.4.3 Ongoing Publicity

Publicity about source separation programs is considered to be a never-ending process. Repeated leafletings are built around progress reports on quantities collected, pleas for more participation, notices of contaminants. Press activity highlights these notices along with contests, awards and features about exemplary families, crews, sponsoring organizations and volunteers. More specifically, press can highlight local debate about mandatory laws, the provision of special containers or stickers, expansion of a pilot program to full scale or cost escalation of refuse management. New public service ads are introduced to radio media periodically. Ads can be voiced by different prominent local personalities from the political, business, artistic and performing fields.

The U.S. EPA implementation manual recommends that ongoing publicity responsibilities be shared by a number of community groups, for instance the university women's club could sponsor a poster contest one month with the scouts distributing doorhangers the following month.(35) Coordinating community group activity is in itself an organizational feat and would be most productive in smaller towns and cities. Whether publicity is carried out by retained consultants or by a municipal department with or without volunteers, at least monthly publicity efforts are recommended for successful source separation programs. It is also important to have an ongoing "hot

line" information service for public enquiries and complaints. In order to reach new residents, the League of Women Voters' manual recommends supplying literature about source separation to Welcome Wagon workers and realtors.(36)

11.5 Examples: Publicity Strategies, Surveys, and Participation Problems

A. Newton, Massachusetts, Case Research:

One reason for non-participation in source separation programs is the perception on the part of householders that they do not generate enough recyclables to make source separation worth the effort. When this attitude was discovered in Newton, Massachusetts, the League of Women Voters undertook to demonstrate the contrary. Ten volunteer families, former non-separators, signed up for a one month test. They separated glass, cans and newspaper from refuse, monitored weights of materials and logged time spent. The newcomers found that the biggest hurdle was setting up a system for kitchen storage. They spent an average of 15 minutes/week separating. They generated 60 pounds of glass/cans and 70 pounds of paper per family over the month, and all planned to continue their efforts as a result of the experiment. Results were released to the press and feature articles about the families resulted.(37) It is useful to publicize household recyclables generation as a motivation to participate and such publicity lends itself to human interest press/media features.

B. New Hampshire Towns, Case Research:

In the Nottingham System of combining reclamation with disposal at town collection centres or landfill sites, participation data are available for five towns.

1. Nottingham: A survey done here found that 75% of residents favour the mandatory separation of glass, cans, newspaper and incinerated refuse. However 9% now take mixed refuse to other disposal sites and 3% dispose of more materials at home. A survey of refuse submitted for incineration shows that there is an average separation compliance rate of 95%. Regarding publicity in Nottingham, it is first important to note that the community had to close its illegal dump.

In spring of 1973, a pamphlet was prepared and mailed to all households by a non-profit research/education ecology group. A public meeting was held in April when a representative from the latter group, a university extension program specialist, and an agent for the incinerator manufacturer explained the new system. Next a town meeting was held to vote in the appropriation of funds and a mandatory ordinance. Over the next five months, four mailings

announced ground-breaking ceremonies, separation procedures, free availability of special containers, "open house" at the collection centre, and start-up date. After an October meeting a group called "Volunteers for Recycling" made a door-to-door canvass with sample containers and answered residents' questions. Four additional mailings over a two year period, provided updates and phone numbers for enquirers.

2. Swanzey: A voluntary source separation drop-off centre is set up at the town transfer site where refuse is assembled for transportation to a regional landfill. Of the residents who bring their refuse to the site, it is estimated that 25%-50% source separate into seven categories of recyclables. For publicity, the Swanzey Conservation Commission prepared and distributed to residents an educational pamphlet which encourages source separation, explains procedures and lists fractions for recovery.
3. Plymouth: Separation is mandatory for glass, cans, news and corrugated. The town collection centre for reclamation/incineration is estimated to have wide public acceptance, and compliance with the separation ordinance is an estimated 95%. Regarding publicity, the community was aware that its illegal dump had to be closed and was aware of Nottingham's success. Two sets of public hearings were conducted, one on the system concept and another on the mandatory ordinance. The hearings were covered well by newspapers and radio.
4. Meredith: This town adopted a centre for reclamation and incineration, but the system is voluntary except for mandatory separation of glass. Source separate participation is an estimated 35%-40% of users but lack of co-operation from the summer resort population is a problem. No estimates of compliance with the mandatory glass ordinance are available. Regarding publicity, public awareness was raised, as in Plymouth and Nottingham, by the need to close an open, burning dump. The town manager carried out a public relations campaign during the construction of the facility. There were several public hearings with guest speakers from the University and the incinerator manufacturing company. The town manager spoke at service club and community group meetings. His administrative assistant designed bulletin board displays within the town offices to promote source separation. A leaflet explaining the importance of and procedures for source separation was piggy-backed with tax bills. Posters were designed by a non-profit research/education ecology group.

5. Durham Regional System: Among the towns serviced by the materials handling plant at the University of New Hampshire at Durham, town officials estimate that participation rates in source separation programs range from 25%-80%. A 10% participation in paper reclamation is estimated for the University itself. It is estimated that 30% of the service area strongly supports the system. Publicity began with source separation advocacy from staff and student individuals. A series of meetings, reports and committees resulted in the expansion of the concept from university to regional level. An organization, called "Students for Recycling", uses posters, displays and news articles as campus educational strategies. The University "Environmental Specialist" also promotes campus source separation, meets with town officials and does public speaking throughout the State. His promotional efforts are complemented by two other reclamation system administrators who have prepared a slide presentation for interested towns. While local town officials undertake local publicity campaigns, most posters and materials are provided by a non-profit research/education ecology group.(38)

C. San Luis Obispo, California, Case Research:

In this multi-material private hauler curbside program, personalized publicity during program planning stages was changed to less personal mass media advertising once collection started. Three surveys were conducted and are outlined below for their significant results:

1. SORT Recycling Survey: This survey had several purposes:
 - To generate information on attitudes and opinions of local people about source separation
 - To educate people who had not yet heard about the program (advice on storage, "end use" of materials, collection times)
 - To re-establish personal contact by a door-to-door survey four months after program startup with an expected increase in participation
 - To research ways of improving the collection system by determining participation behaviour such as set-out frequencies and reasons for not participating (This was done with a view to helping other cities wishing to start or improve programs)

The questionnaire was drafted by a citizens advisory committee and adapted for computer analysis. It was administered to over one third of the single family dwellings in the City by trained volunteers who responded to a newspaper invitation. The questionnaire was carefully designed to test specific research hypotheses with the following findings:

- Awareness: Over 90% had heard of SORT. As a result of the personal survey more people planned to participate but more promises (63%) came from those already aware than from those who had just heard (50%) of the program from the researcher.
- Publicity Effectiveness: Most people had heard about SORT through newspaper articles (43%), followed by brochures (22%) and letters (18%). This indicates that the personalized letters and leaflets were not reliably delivered, received, or read as often as newspapers. Posters, notices in the workplace, and information distributed to school children ranked low enough to be considered ineffective publicity measures.
- Collection Location: Most people set refuse at curbside (80%) and the remainder received backyard refuse collection. Participation in source separation was proportionately higher among the former (70%) than among the latter (40%).
- Participation: Claimed set-out frequency was mainly weekly (43%) or bi-weekly (28%). Participants set out in order of popularity, news (83%), glass (77%) and cans (75%), but differences were not dramatic, leading to the conclusion that three-category separation does not reduce participation. Of participants, only 1% used a local recyclables drop-off centre, but 8% of non-participants took recyclables elsewhere. As over half of the non-participants planned to start and as only two thirds of the past participants planned to continue, authors conclude that overall participation rates would remain relatively unchanged after the survey (63%). Reasons cited for non-participation were unspecified problems (29%), inconvenience (20%), lack of knowledge (13%) and lack of storage space (5%). Among the participants there was no correlation between storage and frequency of set-out despite the expectation that those with storage problems would set out recyclables more frequently. Family size and presence of youngsters did not affect participation or set-out frequency. Women pinpointed inconvenience and storage problems less often than did male interviewees. As mentioned previously, there was a positive correlation between SES and participation.

2. SORT General Participation Study:

Monitoring of set-out behaviour was performed weekly on eight routes for the first five months of the source separate collection. Using a monitoring form, teams of students from a polytechnical school spent 10 person-hours per week driving the collection routes. The driver called out the observed materials at each home for the coder, and questionable set-out containers were opened to differentiate recyclables from refuse. Over 1000 homes/day were monitored. A problem arose because monitors began the collection route an hour before the recycling crew and many participants held set-outs back until the arrival of the recycling crews for fear that refuse collectors would take recyclables by mistake. This behaviour resulted in apparent conservative participation. Study results are as follows:

- A trend toward bi-weekly participation in the first eight weeks, disappeared and became random. Metal and glass participation ranged on various routes from 5%-15% and newsprint from 20%-35%. Important events were matched with participation rates. It was found that rainfall reduced participation. The summer exodus of university students did not reduce participation on routes close to the campus, and overall the summer vacation period did not impact on participation. Of special interest were the effects of concentrated publicity which increased participation in the short term but not over the long term. For example, SORT colouring books were distributed in schools in the same week as slide shows on residential source separation were presented in office buildings to kick off the office paper recovery program. These efforts caused residential participation to soar to 50% that same week but the surge was not exhibited the following week. The door-to-door participation survey which took four weeks, resulted in a small participation rise in the third week but otherwise did not affect participation.

3. SORT Detailed Participation Study:

Conducted at the same time and by the same workers as the second study, this research was aimed at collecting more specific data on overall and individual set-out frequencies, continuing vs. one-time participation, and the differences in set-outs for three fractions as a function of SES. Twelve sample blocks were randomly sampled from six collection routes, and a numbering system was devised for analysis of 175 homes in the study area.

Results of data analysis, leading to the conclusion that collection frequencies must be at least tri-weekly, were summarized earlier in this section. It was also found that newspaper was the fraction

most frequently set out, once every four weeks, except in areas of high participation where it was set out bi-weekly. For all fractions, participation was highest in neighbourhoods with high SES. Middle income neighbourhoods exhibited the lowest participation by fraction and overall, which may be due to the fact that student housing in lower income areas boosted participation there. The authors cite another study where middle class participants had a lower participation frequency than upper or lower classes, except among "regular" participants where middle class participation frequency outranked the other two classes. Glass and metal set-out frequencies were the same for all three socioeconomic groups but newspaper was typically set out most often in high income areas.

According to SORT accounting sheets, a cost of \$200 per month has been budgeted for ongoing education. Startup publicity and education had a price tag of \$9,967, which was almost one quarter of the federal funds granted for the pilot program. For the City's 8000 households, initial publicity cost \$1.25/household. For the 5,200 currently estimated participants (65%), initial publicity was an investment of \$1.92/household.(39)

D. Somerville and Marblehead, Massachusetts, Case Research:

Three surveys have been done in these programs to assess residents' attitudes and participation rates. Again, survey results will be presented in detail because of their significance and because of the paucity of such data.

1. First Survey:

In each town, telephone questionnaires were administered to 75-100 residents selected at random from a telephone directory. Marblehead had an existing separate collection program so the initial feasibility survey concentrated on attitudes toward changes brought about by the new program. 44% voiced no problem with the existing program. Of the remaining 66% who cited problems, these were lack of storage space (33%), infrequent (monthly) collections (29%), confusing (multiple pass) schedules (22%) and preparation requirements (16%). It is interesting to note that in reporting these results, authors do not present a cross tabulation of these problems with participation, viz. are those who voiced problems participants or non-participants? Of all respondents, 66% preferred a weekly collection; 51% favoured a cutback in refuse collection from two days to one day per week, substituting the second with a recyclables pickup. Respondents reacted to a weekly collection by noting that it would solve storage problems, make collection schedules easier to remember and induce more people to start separating.

Somerville residents did not have an existing program so it was desirable to test residents' attitudes toward source separation. 80% had heard of recycling and 82% were willing to participate. 80% felt the program should be mandatory. While more residents preferred a bi-weekly (47%) collection of newspaper than weekly (33%) or monthly (30%), more than half preferred weekly collection (56%) of cans/glass than bi-weekly (36%) or monthly (8%). Half were already keeping newspaper separate from refuse and three quarters had saved newspaper for drives at some point. Perceived problems with source separation were lack of storage space (41%), sanitation (41%) and fire hazard (8%). Respondents were enthusiastic about the program because it would generally reduce pollution, improve cleanliness in the town and bring a financial return to the town. Their preferences for the disposal of profits were to: schools, recreation, trees, elderly programs and teenage problems, in this order of priority.

2. Second Survey:

With the same sampling procedures and sample sizes as in the first survey, the next telephone survey was carried out just before program startup in order to determine the effectiveness of the publicity campaign. In each town, one quarter to one third of the respondents had not received their personal letter of notification about the program. As in San Luis Obispo, more letter recipients were favourable toward source separation than people who claimed not to have received letters. In this survey only 51% of Somerville residents supported mandatory separation compared to 80% in the first survey. Few other results of this survey are available.

3. Third Survey:

After the source separation test programs had been operating for a year, a two-pronged survey was carried out to assess participation rates, reasons for and against participation, effectiveness of publicity techniques and whether programs should be mandatory or voluntary. Personal and telephone surveys were supplemented by monitoring set-out behaviour. Random samples in Marblehead included 50 residents and 299 single family dwelling houses. In Somerville, 100 randomly sampled residents and 452 representative houses (2-3 family units each) were surveyed.

Consultants estimate that the two survey styles, taken together are a good measure of participation. Subjective interviews inflate participation because the subjects want to please interviewers. At-curbside observations (three days in Marblehead and two days in Somerville) deflate participation because some participants do not place set-outs for collection every week. In Marblehead and Somerville, 90% and 60% respectively, claimed to source separate. Curbside inspections

showed set-outs at 74% (Marblehead) and 40% (Somerville) of the sample sites. Actual participation then, was not as high as claimed participation but the 90%/69% claimed levels indicated the potential levels which source separation could reach.

Authors caution against the comparison of data for Somerville and Marblehead for several reasons. In Marblehead, source separation is mandatory, violators can be fined, and a program had existed for three years, whereas in Somerville source separation was voluntary, and had not been practiced previously. Higher income, education, and home ownership in Marblehead implies better understanding, implementation and continuation of a source separation program.

From curbside monitoring, data about type of set-outs were assembled. Among Somerville's set-outs, 34% were cans/glass only and 38% were newspaper only. Among Marblehead's set-outs, these percentages were 30% and 21% respectively. Consequently more Somerville residents set out only one kind of fraction than did Marblehead residents. But in Marblehead, more combined fractions were set out (49% for glass/cans and paper) than in Somerville (28%), a difference which authors attribute to greater experience with source separation.

As a result of curbside monitoring of containerization, it was found that in Marblehead glass/cans set-outs were most often in regular refuse cans (66%) and less often in bags (18%) or boxes (13%). Paper was in paper bags 59% of the time but was also put out loose (13%), in trash cans (12%), in boxes (9%), and bundles (6%). In Somerville, containers were not noted separately for fractions set out. 51% of all set-outs were packaged in paper bags, 20% in boxes, 15% (predominantly glass) in trash cans and 14% tied.

For participation frequency, interview data showed that 55% of Somerville residents and 72% of Marblehead residents claimed to set out recyclables weekly. The actual participation rates from inspections were 40% and 74% respectively. As the claimed weekly participation frequency is close to actual weekly set-out (inspected) rate, then the difference between claimed participation and actual behaviour may reflect irregular habits rather than misleading responses to questionnaires. Asked how often they set out recyclables, only 10% of Marblehead residents said never, compared to 31% in Somerville.

For motivational factors, environmental benefits ranked highest in both communities, followed by financial savings to the towns. Only 19% of Marblehead residents cited legal incentives even though source separation is mandatory. Less than 4% in either town said they

recycled because neighbours did. The latter figure is interesting because many proponents of source separation point to the importance of the visibility of set-outs on collection day as a neighbourhood inducement, but few respondents in these two communities felt this peer pressure. Given the interview situation, respondents would likely choose conservation as a motivation than pressure to conform.

Given a list of publicity measures, mailings were found to be most effective in getting residents involved, 35% in Somerville and 41% in Marblehead. Newspapers came next, 26% and 34% respectively. (Note that newspapers ranked first in San Luis Obispo.) Word-of-mouth was cited by 23% of the interviewees in both towns and posters ranked 1% and 0%. Authors conclude that posters should not be discounted as effective because posters reinforce and sustain ideas presented in other forms. (Note that posters ranked equally low in San Luis Obispo.)

The main reason for not participating in the source separation programs was inconvenience, phrased in terms of time and lack of storage space. The personal financial price of source separation was not cited by either Somerville or Marblehead residents. 13% of those from Somerville cited lack of knowledge of procedures as the reason for not participating, but no one in Marblehead mentioned lack of information. (Percentages for citing "inconvenience", "not caring", and "not enough materials to recycle", were higher in Marblehead but an error in printed data presentation makes comparison dubious--percentages do not sum to 100% for Somerville.)

Of significance is the fact that Somerville residents said they stopped participating when the town failed to make scheduled pickups. Others felt duped when taxes took the biggest leap in recent town history after the source separation program was promoted as a tax reduction measure. In Marblehead, where source separation was already mandatory, 60% of the participants favoured this legislation, but 30% preferred a voluntary program. In Somerville only 26% favoured mandatory separation with 62% preferring a voluntary program. (Preferences for mandatory separation in Somerville were 80% in the first survey, 51% in the second and 26% in the third. Percentages may have declined with experience.)

4. Community Awareness Programs:

To sum up the nine-month publicity campaigns for the source separation programs in Somerville and Marblehead, the following categories are listed:

Newspaper	Calendar Distribution
Commercial TV	Posters
Radio	Schools (curriculum, books, workshops, flyers)
Cable TV	Community Letter
Logotype	Community Groups (contacts, materials, bulletins)
Stickers	

With program startup in December 1975 for Somerville, and January 1976 for Marblehead, newspaper coverage started as early as the preceding July. Community group contacts began in late summer and early fall. In Marblehead, logo competition, school contacts and poster distribution were underway in August and September but in Somerville these activities were held off until November. Two publicity components for Somerville that were not used in Marblehead were mass distributions of calendars and stickers for refuse containers. These costly educational measures were considered necessary for an area with no prior reclamation program.

While the above categories will not be discussed in detail here, the recommendations made by consultants who carried out these campaigns have been incorporated into the overview presented earlier (11.4.1 - 11.4.3) in this section. Actual dollar costs for staff are not available because of incomparability of wage rates paid to two different companies. Person-hours and non-labour expenses are presented below with other extrapolations from documentation of the Somerville/Marblehead community awareness programs.(40)

Table 16: Comparison of Results and Costs of Initial Publicity Programs in Somerville and Marblehead

Item	Somerville	Marblehead
Population	90,000	23,000
"Recovery Rate", October 1977 (41) (diverted disposal)	5%	25%
Participation Rate (42)	40%	74%
Publicity Expenses	*\$8,100**	\$ 850***
Person-Hours	2,300	540
Per Capita Expenses	\$.09	\$.04
Per Capita Person-Minutes	1.53	1.41
Recommended Person-Hours	1,750****	500****

*55% of this total was for calendar design and printing

**Includes one \$1,800 mailing actually paid by the town but represented here as if allocated to publicity budget

***82% of this total was for printing and mailing community letter

****Estimated reduced person-hour expenditure for future programs now that documentation exists for these promotional campaigns

E. Quantitative Research

In a 1974 analysis of twenty-two curbside collection programs, consultants outline the following public relations strategies used for initial and ongoing source separation program publicity:

- Media, and distribution of printed announcements of programs which precede startup date by a month or more and outline goals, collection schedules and procedures; themes (slogans, logos) are effective
- Between initial announcements and startups, continual reminders through local media (newspaper articles, spot announcements on radio and TV)
- Distribution of information (notices in utility bills, printed doorknob hangers) on an ongoing basis. Weekly series in local papers are effective
- Announcements made to/by local civic/service groups on an ongoing basis

Only one half of the case study locations kept cost records for initial publicity. Publicity was usually carried out by ecology groups or service clubs and therefore costs were not allocated to source separation program budgets. Some "out of pocket" costs (excluding donated time or in-kind service/materials) were incurred by program sponsors. These costs ranged from \$.01 to \$.33/household and averaged \$.10/household. Initial publicity for separate truck collection programs amounted to an average of \$.05/household. Publicity materials were mailed or door hangers and flyers were distributed door-to-door by youth groups paid at the average rate of \$.01/household. In contrast, rack program initial publicity costs averaged \$.15/household; city employees were used for leaflet distribution. (U.S. 1974 dollars are presented to illustrate the range and contrast between rack and separate truck program expenditures.)

For ongoing publicity, no case study site was keeping cost records. There was unanimous agreement about the importance of constant public reminders. An example of the tailing off of participation/recovery as a result of no ongoing publicity was a New York City district where twenty-two tons of paper were collected in the first month of operation. This fell to three tons at the six-month point, a phenomenon that was repeated in other New York City districts.(43)

11.6 Summary and Conclusions

Public participation is essential for the success of any source separation program. It is the key challenge faced by source separation as an effective waste management option. In existing research, program "success" may be indicated by participation rates, recovery rates and diverted disposal rates. To some extent, the interchangeable use of these indices inhibits program comparison.

A number of community characteristics are conducive to participation: high SES, existence of ecology groups, smaller community size and high profile disposal issues (site availability and cost). Design components of the source separation system are important determinants of participation. The following summary lists the factors which are key to participation because they either increase the convenience of source separation or help it to become a household habit:

- Comingling of several fractions by householders, at least of cans/glass (a claim of certain advocates)
- Washing, contaminant removal, and flattening, unnecessary for cans/glass
- Curbside collection rather than drop-off centre
- Weekly pickup
- All fractions picked up simultaneously in multi-material programs
- Recyclables picked up on same day as refuse (requires further data gathering to confirm that convenience of same-day service leads to more participation than does visibility of recyclable set-outs on non-refuse collection day)
- Reliable collection service (minimal labour problems and equipment down-time, clear instructions to householders about status of collection during bad weather)
- Special containers for recyclables storage and set-out
- "Hot line" for public enquiries and complaints
- For rural areas, collection centres at regularly used facility, e.g. plaza, post office, school; in towns without refuse collection, depot location at normal disposal site
- Programs of longer duration

Elaborating on the above factors, there is little doubt from existing attitudinal surveys that inconvenience, (lack of storage space, and time for separation) is the main barrier to participation. Confusing collection schedules, and infrequent collection, plague non-weekly collections and those in which fractions are collected on different days in the multiple pass system. The perception of not having enough recyclables to justify the separation effort is another barrier. There is debate in the field as to whether weekly or bi-weekly collection of recyclables is preferable. The latter is more expensive to operate but the former is more convenient for participants. In the most successful recent pilot programs, weekly curbside collection is practiced. While unsupported by engineering data, and not recommended in the most significant U.S. program, simultaneous or same-day collection of refuse and recyclables appears to be more conducive to participation than different collection days. Simultaneous collection of all recyclable fractions is recommended by all but the few proponents of the multiple pass system of collecting fractions, each on a separate pickup day.

Association of a program with goals other than conservation broadens appeal and attracts the support of other community segments. Mandatory separation laws are helpful in the right circumstances but do not alone ensure a successful program. Past newspaper collection programs have had higher participation than multi-material programs but most recent research claims that three-level separation does not inhibit participation. The effect of direct financial incentives has yet to be tested.

Initial and ongoing publicity is vital for sustaining and increasing participation levels. Person-hour and materials expenses differ widely depending on mode of staffing and cost allocation procedures. Initial publicity is easiest to carry out in spring and fall seasons and is less likely to be counteracted by weather-related collection problems. Publicity precedes implementation dates by as much as six months to a minimum of one week. A checklist of publicity tactics would include: slogan/logo, newspaper, TV, radio, community letter/door-to-door canvass/leaflet, posters, (displays, stickers for containers, calendars, provision of special containers, are costly but can be effective) and approaches to businesses, schools and community groups. All of the above measures are aided by donations in time, services and materials from government, businesses, service groups and individual volunteers. Newspaper articles and direct letters have been the most successful publicity measures with posters and school efforts ranking most poorly. Of significance is the documented need for continual reminders about source separation since publicity blitzes have only short-term effects.

In future Ontario source separation programs, sponsors should be encouraged to employ simple survey techniques to determine motivational pitches for use in program

implementation. Survey or other feedback mechanisms and set-out monitoring can be used after program startup to pinpoint problems with programs. A model questionnaire, an at-curb monitoring format and a checklist of publicity strategies should be available for people seeking information from government. These aids could be incorporated into an Ontario guide to setting up source separation programs or be issued as a supplement to such a guide for public, private and volunteer enquirers. Sample logos, slogans, themes and draft community letters would be valuable illustrations in the guide/supplement. In Ontario it would be ideal to test within the same pilot area but among different test groups, the effect on participation/recovery/diverted disposal of i) collection frequency and ii) same day vs. different day collection of refuse and recyclables. Such results would help in designing system(s) appropriate to the Ontario scene.

Throughout this section, reference has been made to the paucity of hard data on participation except in certain heavily subsidized North American pilot programs. Yet participation rates are helpful in assessing what kind of contribution source separation can make to waste management. (Recovery and diverted disposal rates are also helpful and can be deduced from local waste generation and composition data where available.) In order to acquire these participation data, government should encourage source separation program operators to monitor participation as recommended above. As set-out monitoring requires costly, repeated monitoring and tedious tabulation (especially for the more meaningful determination of participation rate coupled with set-out frequency, i.e. who participates and how often for each fraction) government should also consider funding systematic data collection within existing Ontario source separation programs. This data collection requirement should be built into future implementation and funding programs.

SECTION 12

SOURCE SEPARATION PROGRAM ECONOMICS12.1 Introduction

Economic viability is not considered to be the only yardstick of success for source separation programs. Nevertheless, along with determining whether markets exist for recyclables, the paramount concern for most private and public sector decision-makers is the cost of a source separation program. A cost-benefit evaluation of source separation in general, and of individual source separation programs in particular, is problematic for several reasons:

- There is a lack of hard cost data on existing programs.
- There are site-specific factors and program design differences which inhibit the comparison of program costs.
- There are wide variations in subsidies received.
- There are differences in the applicability and calculation of savings attributed to source separation.
- There are different cost allocation methods which, if used, distort program costs.

12.2 Availability of Cost Data

When contacted for references to source separation programs with hard cost-benefit data, staff at the U.S. EPA stated that reports about programs, if done, are sent to EPA without cost details.(1) To rectify this, under new federal waste management legislation, cost accounting records are a condition for mandatory source separation at federal installations and in pilot programs funded by the EPA.

Very few volunteer/social agency sponsored programs keep rigorous records of costs. For instance, among programs highlighted in this research, Arcata Recycling has just begun to log times and costs in its seventh year of existence(2) and Project Arrowhead can only guess that it could break even without heavy labour subsidies if the operation were less labour intensive.(3) Many municipalities running separate collections do not keep track of costs of source separation because reserve/surplus crews and equipment are used. Consequently many newspaper programs appear to operate at no cost as exemplified by Ridgewood, New Jersey's insistence that there are no costs to newspaper collection.(4) In a Massachusetts State government survey of 180 source separation programs, 134 responses were received back but none offered thorough information on cost questions.(5)

Regardless of whether a source separation program is sponsored by the public, private or volunteer sector, the pay-offs of public relations and environmental savings external to the local community, can rank as high, or higher than, strict cost-benefit concerns. Source separation programs are not motivated by financial gain. Political popularity allows programs to continue unless they cost "an arm and a leg". This lack of attention to measurement is not surprising considering that source separation as an "appropriate technology" grew out of the ecological movement of the late 1960's and early 1970's. While there are pockets of resistance to "break-even" business requirements, there is wide recognition that more attention must be given to economics even in heavily subsidized programs. Environmentally motivated sponsors agree that addressing cost-benefit questions is necessary to safeguard the future of source separation as a waste management option.

12.3 Comparability of Program Costs

A. Regional Variations:

While formulae are emerging for use in evaluating program economics in any jurisdiction, the fact remains that data are site-specific. Usually the most costly program variable, wage rates, differ regionally as do equipment costs. On the revenue side, differences in land values and other local refuse management costs, affect calculations of savings in diverted disposal attributable to reclamation. There are regional variations in the market value of recyclables, the presence of alternative markets, and the availability of intermediate processors. In jurisdictions that have no legal landfill option, costly source separation programs are more tolerable than where the need for alternatives is less salient.(6)

B. Program Designs:

Another factor inhibiting comparison of costs is the wide variety of program designs. Generally, collection centres have lower costs than curbside programs. Commercial hauler curbside programs are generally less costly than municipal ones because of greater attention to cost-effectiveness in the private sector. Costs per ton vary with many other components of system design: equipment used, crew size, proximity to market, processing activities, frequency of collection and publicity. Participation is a key variable in spreading fixed costs over a higher throughput. (There are many variables that account for participation as is seen in Section 11.) Further still, another factor which lowers the unit cost of source separation is the expansion from pilot to full scale program. While this involves cost increases (more crews, trucks, etc.), expansion normally achieves higher throughputs and therefore economies of scale. Many pilot programs do not extend to enough households, so high startup costs are not offset by sufficient recyclable quantities.

C. Streamlining:

Cost variations result from seemingly small adjustments that can be made within a system. Streamlining efforts in a collection system can put a floundering source separation program into "the black" as highlighted in other sections of this report. For instance, elimination of a dead-man brake and conversion to hydraulic bucket lifting made a southern California compartmentalized combined refuse/recycling vehicle cost-effective; (7) Ecocycle of Boulder, Colorado designed a collection route with nothing but right hand turns thus slashing pickup time. (8) Elimination of transfer vans for rack collection systems have cut costs, as have decreases in the frequency of collection (with possible loss of participation). Publicity results in surges of participation. Improvement of off-loading facilities for the delivery of recyclables to handling sites is another measure for cost cutting (at the expense of job creation).

12.4 Subsidies Received

Source separation programs are heavily subsidized, making true cost inputs difficult to determine as the following points illustrate. Among the various modes of sponsorship (public, private, volunteer), the following "free" goods and services are rarely allocated as costs to source separation:

- Administration: civil servants such as engineers and clerical staff, and representatives of public service organizations or of businesses involved in planning, day-to-day operation and consulting
- Labour for collection, processing and hauling: ecology group volunteers, prisoners, parolees, probationers, disadvantaged youth, disabled persons, senior citizens, personnel provided by businesses, labour from reserve municipal crews, and workers acquired through government job-creation and retraining programs at no cost to the source separation program
- Equipment for collection, storage, processing, hauling: donated by business, "make do" scrounged, funded by government, modified or borrowed from reserve equipment pools; storage containers and hauling provided by materials buyers not always reflected in lower revenues per ton purchased
- Central handling site: already used for mixed waste handling or donated
- Publicity: carried out for "free" by civil servants or community groups; public service air and space from news media
- Startup costs for consulting studies, planning and equipment: government funding programs for waste management alternatives and capital infusions into existing programs that allow fledgling programs to "take off"

There is nothing inherently unsound about the above subsidies unless dependency on donations makes it impossible for a program to operate when donations are withdrawn. The fact that source separation is receiving so much government, commercial and volunteer "good will" is indicative of its perceived social value. However when the question of program cost arises, it can be seen that costs are often inversely correlated with subsidies unless opportunity costs are assigned to donations. No examples of this accounting technique were found in this research; consequently, program costs are deflated depending on the kinds of subsidies that are not calculated as costs.

12.5 Availability and Calculation of Savings

It is generally agreed that tonnages diverted from collection and disposal should rank as credits to source separation in addition to revenues from the sale of recyclables. In some locations these savings are equal in importance to sales. But real dollar credits vary with several factors such as:

- A. Whether the source separation program sponsor owns disposal facilities or pays a third party for refuse collected
- B. Whether a municipal or private collector of recyclables and refuse is able to cut garbage collection costs (fewer crews and trucks, more efficient routing)
- C. Whether local government is prepared to forward real dollar payments to volunteer or non-profit program sponsors responsible for diversion of waste
- D. Whether diverted amounts have a sufficiently large impact on garbage amounts to warrant a credit

Discussion on these points follows.

A. Disposal Site Savings:

Real dollar disposal savings are possible when private or municipal haulers collect refuse and recyclables, and pay a third party for refuse disposal. The per ton or per load tipping fee saved through source separation, is credited directly to source separation. If the source separation program sponsor owns and operates a disposal facility however, only a portion of the disposal cost can be saved. An early study on source separation economics outlines a technique for arriving at these savings.(9)

The above study shows how savings can be calculated for the extension of site life and the decrease in equipment usage for landfill operations. Data inputs vary with local circumstances. Dividing net per acre land values by tons per acre filled, gives an estimate of decreased land use per ton of diverted recyclables. Operating cost per ton credits can be determined by dividing local equipment and operator costs per hour by the number of tons of garbage spread and compacted per hour. Adding these land and operating costs gives the amount that can be credited to each ton of garbage diverted through source separation when a site is owned by a municipal or private program sponsor.

The above study also shows how source separation can reduce equipment use and residue disposal requirements for incineration operations. Incineration inputs vary with local circumstances but usually include: operating labour; maintenance and repair; administration and supervision; pension; fuel and utilities; amortization and miscellaneous. While many of these costs are fixed and not affected by diverted recyclables, at least operation, maintenance and repair can be credited to source separation. Furthermore, incinerator ash must be transported to landfill at costs which vary with many factors, especially haul distance and the percent of volume and weight reduction for incinerated materials. A volume reduction of 95% may be achieved by incinerating paper but combustion does not reduce the volume of glass and metal; therefore, if paper is the only fraction collected in a source separation program, incinerator residue transport reduction will not be dramatic; if cans and glass are source separated, incinerator residue hauling savings attributable to source separation will be more dramatic.

To arrive at a credit for materials diverted from incineration, a municipal or private source separation sponsor who owns an incinerator site would add the variable cost per ton of incineration and the landfill cost per ton calculated above and the residue transport cost per ton. If the program sponsor pays a third party for transfer and incineration, then these fees can be fully credited to source separation.

B. Garbage Collection Savings:

When private or municipal haulers collect refuse and recyclables, either of these sponsors may be able to attribute savings in garbage collection costs to their source separation programs. Savings may result when refuse tonnages diverted through source separation, are sufficiently great to allow cutbacks in refuse collection crew size, equipment and number of collection days. More efficient refuse collection routing may also be possible because packer trucks fill more slowly and make fewer trips to off-loading facilities.

Indications are that this trimming is rarely done, especially in municipal refuse operations, because of delicate labour relations, fixed equipment costs, and failure to take advantage of reduced amounts of collectable garbage. Cut-backs in regular garbage collection are usually possible in inefficient municipal operations even without diverted tonnages. Source separation may provide the political impetus to make such changes. This can occur whether or not a source separation program is diverting substantial amounts of refuse.

For the operators of concurrent refuse and source separate collection operations, the impact of source separation on refuse collection costs, is not clear cut. Overall collection costs may increase if high fixed refuse collection costs are supplemented by an additional source separate collection program. Overall costs may remain the same or decrease if surpluses (crews, trucks, routes, days, etc.) resulting from cut-backs in refuse collection, are transferred to the source separation collection. A decrease in overall costs may be due to efficiencies not specifically related to source separation, i.e., cutting all crews from three to two persons. Over time, source separation may increase its impact on overall collection costs. For instance, part of an old packer fleet could be replaced by cheaper and lighter source separate collection vans.

A different approach must be taken to the topic of refuse collection savings when municipalities contract out garbage collection to commercial haulers. If the municipality pays a flat rate or a per capita rate for garbage collection, there is little incentive on the part of the municipality to operate its own source separate collection. The City would incur the costs of separate collection without enjoying any collection savings, until future refuse collection tenders were revised to reflect diverted tonnages or were changed to a per ton payment basis.

Under contract to a municipality for refuse removal on a flat rate basis, a commercial contractor with a source separation program could enjoy savings in refuse collection costs at the expense of the contracting municipality. Here again, it would be advantageous for the City to renegotiate future refuse contracts on a variable rate basis.

C. Rebates:

Volunteer groups, social agencies and non-profit companies do not usually collect and dispose of garbage. These source separation program sponsors can expect no direct credits for tonnages diverted from the waste stream. Where an arrangement can be worked out with municipal or commercial

refuse haulers who value source separation as a service, volunteer groups and others may receive a grant per ton equivalent to collection and disposal savings. It should be noted that these payments may not reflect real dollar savings to refuse haulers because of the high fixed costs of refuse management. Some federated source separation groups in the Recycling Council of British Columbia receive such payments.

The debate about whether source separation is a business or a service deserves some elaboration. Dealers, haulers and scavengers have always made their livelihoods from waste collection, disposal and resale. Within the last ten years there has been the appearance of companies spawned from environmental groups, the recent development of intermediate processors, and the reclamation ventures of social rehabilitation agencies. These indicate new business opportunities perceived in source separation. Nevertheless none of the three is living more than a hand-to-mouth existence and all are pressing for capital grants and labour subsidies. The newcomers think it is ironic that source separation is expected to operate in the black or break even when conventional waste management is accepted as costly to the public purse. This service or business debate also surfaces when municipal officials must decide whether source separation is financially justifiable.

Seen as a service, source separation costs (losses) are tolerated by municipal and commercial haulers. For non-profit companies, source separation, seen as a service, would be entitled to rebates from the normal refuse hauler. Seen as a business, source separation is expected to be self-sustaining under all three modes of sponsorship. The very question of cost-effectiveness depends on this service-business outlook, on the cost of local waste management activities, and on the mode of sponsorship: public, private, volunteer/non-profit.

The following chart attempts to clarify the applicability of various real dollar and/or redeeming non-dollar advantages of source separation for the three sectors.

Table 17: Applicability of Real Dollar Savings and Non-Dollar Advantages of Source Separation

Revenue or Saving Item	Mode of Sponsorship		
	Municipality	Commercial Hauler	Non-Profit or Volunteer Group
Recycling pickup collection fee charged	not applicable; collection is the responsibility of the municipality	no examples found where fee greater for source separation than for refuse collection	west coast groups only, limited examples
Disposal site fee savings	if pays third party	if pays third party	not applicable but may receive rebates for tons diverted
Disposal site life and operating savings	if owns site and also if amount diverted through source separation is substantial	if owns site and also if amount diverted through source separation is substantial	same as above
Collection savings	if collection not contracted out as flat rate, and if own system streamlining possible	if streamlining possible in refuse collection system	same as above
Materials revenue	important except where no other disposal option justifies a low revenue program	strong incentive	important in legitimizing program
Non-monetary factors which justify losses	no other disposal option; community pride	public relations; experimentation with pilot program	ecology/conservation motive
"Subsidies"	slack in refuse system (labour, equipment); grants; costs hidden in refuse budget; community organization does publicity	demonstration and job-training grants; equipment available already; community organization does publicity	donated labour, services, site, publicity, etc.; demonstration and job-training grants

D. No Savings:

In an extreme case, not found in this research, it is possible that high recyclable diversion rates would raise collection and disposal costs for garbage. High fixed costs would not be spread over enough refuse throughput, resulting in a higher cost per ton for mixed waste. In fact it is this fear that is causing municipalities to legislate "flow ordinances" that guarantee garbage levels for mechanical resource recovery/RDF plants. While not due to reduced refuse throughput, the rack system (for collecting newspaper on refuse packer trucks) can result in higher refuse collection costs when source separate recovery is high. Incremental time spent in reclamation activities can prevent crews from completing refuse responsibilities.

12.6 Allocation Methodologies

So far this discussion of the state of the art for source separation economic analysis has pointed out several barriers, i.e. the availability, comparability and uniformity of cost-revenue data. While the lack of available hard cost data makes programs hard to evaluate financially, the lack of comparable and uniform data is not a problem as long as formulas exist for plugging in local estimates. Such formulas do exist.

The accounting methods being applied to source separation programs are known as the incremental and the full cost approaches, with various modifications. But the same source separation program can be made to look financially dismal or bright depending on which method is used: Program economics then, becomes a question of whether a source separation program is viable as well as how costs are calculated. The method of allocating costs varies in its usefulness with the mode of sponsorship of a program, the stage of the program (pilot or full scale) and how the question of economic viability is posed. First the methodologies will be defined and contrasted.

A. Accounting Methodologies Defined

- Fully Allocated Cost Approach:

Source separation program costs are evaluated independently of the refuse collection system. All source separation expenses for equipment, labour, site and so forth are counted (allocated) as costs of source separation even if these costs were not actually incurred, i.e. they were already budgeted to refuse collection. Thus if equipment and personnel are shared by the refuse and source separation systems, costs are allocated to source separation in proportion to the time spent in that activity.

- Incremental Cost Approach:
A source separation program is evaluated along with the existing refuse collection system. Costs in the overall refuse collection system are compared before and after implementation of a source separation program to arrive at the additional cost/savings resulting from source separation. Expenses are allocated to source separation only if actually incurred, i.e. source separation costs incremental to costs budgeted for regular refuse management.
- Modified Incremental Cost Approach:
Joint evaluation of refuse and recyclables systems may be retained but some costs that would not be allocated under strict incremental accounting are apportionately attributed to source separation.

An illustration will help to contrast these methodologies. For instance, a forklift truck used at a refuse site is drawn into service when recyclables from a source separation pilot collection program are delivered to the site for off-loading and storage. Under the full cost approach a portion of the forklift's depreciation, fuel, maintenance and repair would be allocated to source separation. Under the incremental approach no costs would be allocated to source separation because the truck is part of an existing refuse equipment pool and is not used full-time for source separation. On a modified incremental basis, the truck's fuel and maintenance but not its depreciation would be allocated to source separation because the first two are easily identifiable costs of source separation functions. This example could be extended to all components in a source separation program: administration, operating labour, and equipment for collection, handling/processing, storing and hauling.

There are arguments in support of both full and incremental approaches, but both distort program costs and benefits of source separation. The fully allocated accounting technique inflates the costs of a source separation program when items are allocated even though no "out of pocket" expenses are incurred. For instance, administrative duties may be absorbed by engineering staff, labour may be available from a reserve pool and an underutilized vehicle may be used for collection. None of the above costs is actually incurred, but in fully allocated costing, all apportionate costs would be assigned to source separation.

On the other hand incremental accounting deflates the costs of source separation by highlighting the additional costs of source separation but by leaving unstated, expenditures for source separation that are budgeted into the trash collection system. In the above example, some of the items may represent opportunity costs such as the administrator who could be carrying out other duties or a piece of equipment that could be used elsewhere. In the incremental approach, a source separation program can be calculated to show a net savings to the entire mixed trash system, whereas in the fully allocated approach, the full cost to collect recyclables in the same program may not be offset by revenues and disposal savings.

B. Applicability of Accounting Methodologies

The real question is which method should be used by a source separation sponsor to represent program costs. Alternatively, which technique is more useful to a potential program sponsor who is gathering financial viability data on existing source separation programs elsewhere in order to determine whether to implement a local program.

A volunteer outfit, or non-profit business will want to know if revenues from recyclables at least match (unsubsidized) collection costs. Full allocation is applicable because no mixed refuse program is operated. Full cost allocation may also be useful if a source separation pilot program is expanded to the point where it will operate independently of the labour and equipment of the municipal or private refuse collection system. It could also suit a separate truck program because refuse and recyclables are collected in different vehicles. But in both of the latter cases, where costs are fully allocated to source separation, the resulting efficiencies or losses in the refuse collection system should be viewed as net savings or losses for the entire waste management system.

Incremental accounting suits integrated or rack collection systems and is useful for public and private haulers with some "slack" in their refuse collection operations. But for such haulers without "slack", a modified incremental approach with some costs fully allocated, would more fairly expose additional source separation costs that would be buried in the waste budget under the strict incremental approach.

An early analysis of twenty-two case history curbside collection programs was done in 1974. Confronted by the array of accounting methods used, and the lack of quantified data, authors adapted a refuse collection model in order to evaluate the economics of separate

collection, namely, 1) the costs of separate collection; 2) the savings and revenues due to separate collection; and 3) the impact of separate collection on mixed refuse collection. The model involves seven efficiency factors, three assumptions, eight physical and four cost variables, and seven calculation steps.(10) It is too specific and detailed to be represented in this report but further economic evaluation should determine its applicability to Ontario and its usefulness in relation to a proposed Ontario accounting and monitoring system.(11)

Comment:

When existing program sponsors represent their costs and benefits for use by other decision-makers, it is most useful to outline both full (as if there were no reserves from which to borrow) and incremental (actual) costs, accompanied by savings/costs (incremental) to the entire waste system (refuse and recyclables). There should be an indication of what costs were borne by outside agencies such as volunteers or government funders (opportunity costs imputed to subsidized components). Fixed startup costs should be shown segregated and amortized over a fair period of time as the cost of change over the life of a system. These "once-only" costs should be offset by the benefits of economies of scale resulting from repeated and extended operations. The incremental approach is generally considered to more fairly represent the impact of source separation on the whole waste management system comprised of a new source separation subsystem and a revised, presumably less costly, old mixed waste subsystem. But it is important to delineate what items have been borrowed for "free" from other budgets along with actual "out of pocket" expenses.

12.7 Examples of Specific Source Separation Program Economic Analyses

A. Marblehead, Massachusetts:(12)

At present, this municipal multi-material curbside collection program is widely recognized as the only existing financially successful source separation scheme in the U.S. Following are the assumptions, cost components and sources of data used by consultants retained to evaluate program economics for the year ending in December, 1976. Full and incremental accounting techniques are combined.

Revenues:

Sales range from \$1,592 to \$3,831 with an average of \$2,966 per month for paper, glass and metal hauled to and sold to an intermediate processor. Revenues are affected by some variations in quantities and extreme variations in prices paid.

Savings:

Disposal fees per ton of reclaimed materials are credited to source separation. The private landfill charge, including transportation, to the city, is \$18.95 per ton. Extension of landfill life and site operation are not calculated as credits. Refuse collection costs for manpower and vehicles are reduced because 24.4%, or just under one-quarter, of Marblehead's waste is reclaimed through a separate pickup. These decreased waste collection activities are credited to source separation.

Costs:

- Administration: Costs are borne by a Director of Public Works and a three-member Board of Health plus small costs for bookkeepers, auditors, accountants, lawyers, secretaries, and overhead. These costs are not allocated.
- Publicity: Startup and ongoing public education expenses were \$3,000 for a 1½ year period up to December, 1976. Neither publicity expense nor labour (consulting fees) is allocated.
- Equipment: Two compartmentalized recycling vehicles cost \$42 per collection day. In addition to maintenance and consumable fuel, this cost includes depreciation even though the trucks were purchased by the federal government (included in order to make calculations applicable to other municipalities). Three recycling bins remain at a drop-off location for the convenience of residents. The bins are rented for \$195/month and cost \$55 per haul to market. It is instructive to note that four refuse packer trucks cost \$82 per collection day in this locality at that time.
- Labour: Two 3-man recycling crews would cost \$262 per day (wages and fringe benefits) on a full cost basis but actual "out of pocket" costs are zero because no additional labour was hired for source separation. All six workers are drawn from surplus labour no longer needed for refuse collection. These labour costs are allocated on an actual cost basis as outlined below.

Net Savings on an Actual Cost Basis:

Net savings on an actual cost basis is a calculation used to depict the overall financial loss or benefit to the waste management activities of the municipality. It is defined as revenues plus (collection and disposal) credits minus actual costs, and amounts to a \$27,850 "profit" for Marblehead compared to total collection/disposal costs of \$274,000. Actual costs as above, do not include administration or publicity costs and exclude landfill capacity/operation credits.

As a backup to the net savings analysis, calculations of recyclables revenues of \$35,595 and disposal credits of \$40,135 are combined as gross savings of \$75,730. Cost backup data include labour and equipment source separate collection costs of \$75,288 and bin costs of \$5,124. It is important to note that source separate collection costs assume the utilization of additional labour and equipment, even though equipment depreciation and crews are not out-of-pocket costs. Collection costs are therefore represented in two ways: first as fully allocated to source separation and secondly as actual costs credited with the labour and equipment no longer needed for regular refuse collection. In other words, in the actual cost approach, fully allocated labour costs of source separation are cancelled out by fully allocated labour savings of refuse collection. Consequently, full collection costs of \$80,362 are almost twice as much as actual collection costs of \$47,878. Net savings on a full cost basis (materials revenues plus credits less full costs) is a negative figure, a loss of \$4,682. But net savings on an actual cost basis (materials revenues plus credits minus the actual costs which, as above, include credits from labour and equipment no longer needed in the refuse system) is a profit figure of \$27,850, on an incremental accounting basis.

More recent data(13) indicate that for the period from January to October, 1977, several changes took place in Marblehead's program economics. These include lower revenues for recyclables, increased labour costs and a change to once a week refuse collection which eliminated a packer truck and its collection crew. Accompanying these cost shifts, net savings on a full cost basis is still a negative figure, a loss of \$21,154. Net savings on an actual cost basis amounts to \$12,314, a positive figure.

B. San Luis Obispo, California:(14)

This private hauler multi-material curbside collection program was implemented in 1977. A consultant's evaluation of program economics was federally funded.

In the above report, projected economics and analysis for the first half year are geared for private haulers who would simply want to observe whether revenues from source separation could meet or exceed direct costs. San Luis Obispo Garbage Company wanted to know the incremental cost or saving due to source separation. An incremental cost approach is heavily modified to include the full allocation of many source separation costs already budgeted under refuse activity. No attention is given to savings accruing to total waste management operations as a result of the source separation program. This the modified incremental accounting approach is truncated by not looking at the total

waste system. Five cost-revenue categories are evaluated as follows. It is important to note that three parties, government, consultant and hauler are displayed as one, to make cost information useful to other decision-makers.

1. The collection system:

- Capital: Collection, storage and transfer equipment, some of which was already part of the hauler's operation but fully allocated to source separation. Some of this used equipment was modified and capitalized as a startup cost with a five-year amortization. Subtotal capital costs were \$15,050, for a monthly cost of \$325.
- Startup: Initial (incremental) costs, other than capital: labour for equipment preparation; administrative time for planning and marketing; miscellaneous travel; and attachments required for vehicle modification. Subtotal startup costs were \$730 or \$6 per month after capitalization.
- Operating: Variables required for the ongoing collection and processing of source separated recyclables: wages and benefits for the two-man collection crew hired especially for source separation; equipment, fuel and maintenance costs, inflated by major overhauls in the testing of equipment; costs apportionately allocated to source separate material storage on land leased for regular refuse transfer. Subtotal operating costs were \$2,156/month.

A total collection system cost of \$2,488 was raised to \$3,144 per month with the allocation of 10% general and administrative overhead, and 10% profit.

2. The transportation system:

- Labour: Manual transfer of newspaper from storage bins into a transport van (initially done by prisoners for supervisory costs and later by special hires) and mechanical transfer of glass from storage box into a truck--a subtotal of \$68 per month.
- Hauling: Transport of newsprint and metal by affiliated local trucking companies at \$200 per haul for seventeen hauls, less several back-haul discounts--a subtotal of \$567 per month.

Labour and haulage came to \$635 per month.

3. Program development and operation: (included two categories)

- Startup: Consulting services (less evaluation and reporting time) cost \$10,000, project manager salary for six months cost \$5,366 and publicity program cost \$9,967--all capitalized at 10% interest as \$83, \$45 and \$83 per month respectively.
- Administration: Part-time project manager whose time was 1/4 allocated to source separation at \$224 per month; ongoing publicity at \$200 per month and miscellaneous clerical at \$100 per month.

While program development came to \$735 per month, it is not allocated to the hauler's source separation costs but is represented as a cost item for other observers.

4. Revenues from material sale:

<u>Item</u>	<u>Tons</u>	<u>Price/ton</u>	<u>Total Revenue</u>	<u>Monthly Revenue</u>
glass	171	\$ 15	\$ 2,565	\$ 427
metal	54	\$ 45	\$ 2,430	\$ 405
newsprint	223	\$ 40-50	\$10,035	\$ 1,673
	<u>448</u>		<u>\$15,030</u>	<u>\$ 2,505</u>

5. Credit for disposal:

The 5% recovery rate of citywide solid waste attributable to source separation was calculated to be a 1½-year extension of landfill (owned by the hauler) site life. But as the disposal operation was not sensitive to small changes, and as the landfill received wastes from an entire county, no credits were given to source separation for its impact on diverted disposal.

The results of the above analysis indicate that the net cost of source separation collection and transport was \$1,274 per month. This was the incremental loss of running a source separation program in addition to normal waste operations. But the figure would have been higher if \$735 for "program development and operation" had been allocated to the program sponsor. It may have been lower, if analysis had been extended to the savings to refuse collection as a result of the source separate collection. (Current claims are that the hauler may be breaking even as householder participation has soared to 65%.)

Comment:

The two examples cited from Marblehead, Massachusetts and San Luis Obispo, California, are the two top (1978) multi-material source separation programs in the U.S. One shows either an annual profit or a loss depending on how costs are allocated, and the other shows a monthly loss which could be raised or lowered by further calculations. Neither study adheres to rigid incremental cost accounting because both are attempting to be useful to other decision-makers. A choice of formulas for assessing the program economics of source separation may not in itself indicate a confusion in the state of the art, but as long as accounting methodology is discretionary, the question of source separation program viability will have to be jointly, "how much" and "how calculated".

12.8 Summary and Conclusions

The measurement of costs and benefits of source separation is beset by such problems as the lack of hard data, wide regional and program design differences, subsidization, variations in the applicability of creditable savings, and accounting methods that distort "real" costs of source separation. As ecologically motivated source separation programs evolve, application of business principles is increasing despite the lack of rigorous documentation of costs.

Since source separation programs are heavily subsidized through donated services, volunteerism, reserve equipment, surplus labour and government grants, many program costs are hidden. These hidden costs should be represented in cost-benefit analyses in order to depict the full costs of source separation programs along with actual out-of-pocket expenses. Full costs will always be greater than actual costs. The U.S. EPA recommends that both full and actual costs should be outlined for source separation programs in order to be useful to other decision-makers.

Any Ontario program should include the following accounting tasks which could be published as a format in an Ontario source separation implementation manual.

A. Accounting Principles:

- full costs, as if no goods/services donated/borrowed; includes imputed opportunity costs;
- incremental costs actually incurred over and above budget for existing refuse operations;
- startup costs represented separately and amortized/capitalized over a fair (3-5 years) period of time including labour and grants from outside agencies;
- credits from revenues, diverted disposal and increased efficiencies in any existing refuse operations.

B. Basic Cost-Revenue Format Inputs (Format Requires Further Organization and Refining)

Item	Costs Fully Allocated*	Actual Out-of-Pocket Costs**
<p><u>COSTS</u></p> <p><u>Equipment</u>: capital (amortized, depreciated), rental, fuel, repairs, maintenance, etc. for:</p> <ul style="list-style-type: none"> - collection - transfer (on- and off-loading, all stages) - processing - storage - hauling <p><u>Labour</u>: wages and benefits for:</p> <ul style="list-style-type: none"> - collection - transfer - processing - hauling - site maintenance - administrative: co-ordination, clerical, publicity <p><u>Site</u>: lands and buildings; capital amortization, taxes, lease on land; building capital, rental and maintenance</p> <p><u>Startup</u>: not already capitalized above, i.e. initial publicity, planning, consulting - spread over a 3-5 year period</p> <p><u>Ongoing Education</u>: expenses only</p>		
Total Costs/unit of time		

Basic Cost-Revenue Format Inputs (continued)

Item	Costs Fully Allocated*	Actual Out-of-Pocket Costs**
<p><u>SAVINGS</u></p> <p><u>Revenues:</u> material sales, each fraction</p> <p><u>Fees:</u> collection pickup fees if applicable</p> <p><u>Disposal Diversion:</u></p> <p>a) actual access fee/ton or load, including transfer, OR</p> <p>b) extended site life and operating costs saved, including transfer</p> <p>(For source separation sponsors without refuse operations this credit could be awarded as a recognition of the impact of source separation. Credit (a or b) may appear on paper, or be transferred as a cash revenue by a municipality or private hauler paying third parties or operating own facilities.)</p> <p><u>Collection Efficiencies:</u> as a result of decreased requirements for labour and equipment if rerouted (as in disposal diversion, non-profit sponsors may be entitled to paper or dollar credits).</p> <p><u>Other Grants:</u> subsidies, donations</p>		
Total Savings/unit of time		
<p>*Includes apportionate costs of shared items and cost estimates for "free" items.</p> <p>**Includes only actual expenses incurred.</p>		

Back up calculations:

- Logs for all labour activities and equipment operation, including fuel, i.e. labour cost (\$/day) + equipment cost (\$/day) X collection/processing days/month.
- Revenue logs for recyclables, i.e. tons X market price = revenues.
- Cost and tonnage logs for refuse operations if applicable.

Arrive at:

A. Total Costs less Total Savings =

$$\frac{\text{Net Savings (Loss)}}{\text{Tons Handled}} = \text{Fully Allocated Savings (Loss)/Ton}$$

B. Total Costs less Total Savings =

$$\frac{\text{Net Savings (Loss)}}{\text{Tons Handled}} = \text{Actual Savings (Loss)/Ton}$$

SECTION 13

SOURCE SEPARATION LEGISLATION AS A SPECIAL CONSIDERATION13.1 Introduction: Mandatory Source Separation

In voluntary source separation programs, householder participation is requested. In mandatory programs, participation is required by local laws which obligate householders to separate recyclable materials from garbage.

There is evidence that increasing numbers of U.S. cities are passing ordinances (the U.S. term for local bylaws), which mandate separation.(1) For example, there are fifteen mandatory ordinances in the State of New Hampshire.(2) Out of the 180 source separation programs in the State of Massachusetts, thirteen are mandatory programs.(3) There is pressure from enthusiastic ecology groups for such legislation.(4) Nevertheless, municipalities are reluctant to legislate behaviour. While mandatory programs may help instill the responsibility to separate on the part of some residents, it is feared that forced participation could also cause negative public response to source separation programs.(5)

Making source separation a legal obligation raises questions about enforceability, public acceptance, and appropriateness where markets are not secure. Aside from these, the central question is, do such laws increase the success of a source separation program. That is, do mandatory programs capture more recyclables from the waste stream or have higher participation rates than do voluntary programs?

The ideal way to answer this question would be to obtain research results which measure the effect of mandatory laws on amounts reclaimed, when all other components of system design are held constant in a large sample of source separation programs. No such data appear to exist.

13.2 Quantitative Research on Mandatory SeparationA. SCS Engineers:

In a major report on U.S. cities with source separate collection programs, authors recommend that programs should begin with voluntary source separation. This voluntary phase provides a barometer of public acceptance, before the program is made mandatory. Areas having or considering ordinances at the time were: Great Neck, New York; Hempstead, New York; West Hartford, Connecticut; Greenbelt, Maryland; Villa Park, Illinois and Marblehead, Massachusetts. The mandatory locations started with voluntary programs and adopted ordinances after the programs were well received by the public.

The above study shows that mandatory programs had an average participation rate of 60% while voluntary programs, only 30%. But other variables -- frequency of collection, socioeconomic status, publicity and preparation stipulations -- are thought to be more responsible for the spread. Program duration is thought to be most relevant, because data indicate that participation rises over time. When programs reach the age of two or three years, the success difference between mandatory and voluntary programs was expected to diminish. The authors conclude that an ordinance by itself does not guarantee participation. (6)

B. U.S. Environmental Protection Agency:
In 1977, the U.S. EPA mailed a questionnaire to 216 U.S. cities, thirty-five of which have collection programs for recyclable fractions other than newspaper. Information about mandatory ordinances was sought, but few questionnaires were returned. Another survey was done in 1978 in order to identify variables responsible for high recovery and participation in programs. According to EPA spokespersons, their report draft indicates that mandatory ordinances alone do not ensure high recovery. Spokespersons emphasize that good publicity must accompany ordinances. (7)

13.3 Examples of Mandatory Separation from Interviews and Case Studies

A. Somerville and Marblehead, Massachusetts:
In these multi-material test programs, source separation was voluntary in Somerville, and is mandatory in Marblehead. In Somerville the percent of residential waste recovered was 8.1 and in Marblehead, that percentage rises to 24.4. At first glance these simple figures point to the impact of a local ordinance but again, program designs differ widely. There are striking differences in socioeconomic status, and Somerville suffered major labour and collection disruptions when the program was operating.

Marblehead's recovery rate has more than doubled since an improved curbside collection program was implemented in January 1976. This replaced a program started in 1972, that had limited publicity, a confusing collection schedule, and required more household segregation effort. Yet separation was mandatory under both programs. The doubling of recovered tonnages is the result of streamlined program design, and not due to the ordinance alone. (The ordinance has never been enforced.) (8)

B. Barrington, Rhode Island:

When its program was voluntary, Barrington's collected newsprint amounted to 18 tons/month. But when separation of newspapers was made mandatory, collected newspaper jumped to 20-25 tons/month with a full doubling of other materials collected at the drop-off centre. This rise in both curbside set-outs and depot drop-offs has been triggered not only by the enactment of the ordinance, but also by the publicity associated with that political gesture.(9)

C. Stoughton, Massachusetts:

When its local dump was closed, the town switched to a transfer station/regional dump system. An ordinance has not been enacted, but source separation is presented as mandatory resulting in the diversion of 20%-25% of the waste-stream through reclamation.(10)

D. Nottingham System:

Ordinances mandating separation are an integral part of the combined recycling-incineration/landfill systems being adopted in the New England States. Under pressure to close illegal local dumps, the first town to adopt an alternative was Nottingham, New Hampshire. The system involves a town collection centre for source separated recyclables and burnable trash which has been in operation since 1974. Both residents and town garbage haulers must deliver wastes sorted into four categories, or incur a \$10.00 fine under the ordinance.

Several other communities in New Hampshire have adopted with some modifications, the Nottingham System and ordinances. For example, separation is mandatory in Plymouth, mandatory for glass only in Meredith, mandatory in a few of the towns served by the University of New Hampshire at Durham, and voluntary in Swanzey. Newspaper, glass and cans are recovered in all five systems, which differ in their recovery of corrugated, mixed and high quality papers.(11)

Proponents of the Nottingham System put heavy emphasis on mandatory separation as essential to the economic viability of any small scale recovery system. Allowing separation as an individual option is not cost-effective for the efficient operation of the pyrolytic incinerator and for the long hauls to market. Yet proponents quickly point out that legal requirements should only be a product of a vote by an informed citizenry to ensure wide-spread support. Mandatory source separation would likely be supported by the public in an isolated town which has committed revenue to an incinerator that would be rendered less efficient with the addition of glass and metal. Where markets for materials are available and where landfill is not available, public support would not be difficult to marshal. (12)

E. Seattle, Washington:

A different approach is taken to mandating in a Seattle source separation pilot program. Here there are three test groups: mandatory limit to trash; voluntary source separation; mandatory limit to trash combined with voluntary separation. The purpose of the pilot is to test which group generates the least garbage and the most recyclables. But it is the garbage set-out behaviour, not the source separation practice, which is mandatory.(13) Thus test group differences will not answer the question posed in this section, that of whether mandatory separation is effective.

F. Federal Facilities:

In the U.S., federal legislation mandates the source separation, separate collection and sale of waste newspaper in all army facilities where more than 500 families reside. A procedure for market identification and cost reporting is also mandatory. But source separation measures for cans, glass, and mixed paper are only recommended because of fewer available markets. Under this law, other mandatory procedures apply to corrugated paper from commercial establishments and high-grade office paper at all federal installations in the country.(14)

13.4 Summary: Mandatory Separation

To summarize current decision-making on mandatory source separation, the following observations can be made:

- Bylaws requiring source separation are only applicable where markets are guaranteed, promotion is heavy, and collection/depot systems are efficiently run.
- There is reason to believe that program duration, high socioeconomic status, good publicity, frequent collections, and minimum householder effort are the combined factors in successful source separation programs, obviating the need for bylaws mandating separation.
- Nevertheless the direct or delegated vote for mandatory separation has a triggering effect, because such a law is accompanied by publicity and indicates official endorsement of a program.
- Psychologically, a legal obligation to separate implies that overall participation will be high. With this "assurance", individuals may be convinced that their own small efforts are worthwhile.

- There could be a public backlash to enforced separation unless proper education is carried out in order to emphasize the saliency of waste reclamation.
- Municipalities with existing source separation programs are considering laws to reinforce participation, but not to force it. Charitable and ecology groups are also pressing for such laws.
- Where mandatory ordinances exist, they are seldom, if ever, enforced. They appear to be enacted in order to put an official stamp of approval on a program, rather than to police and enforce source separation.

13.5 Other Legal Techniques

A. Anti-Scavenging Ordinances:

Due to pilfering problems, many municipalities have enacted anti-scavenging laws prohibiting paper pickups by any party other than the municipal department in charge of collection or other than licensed haulers. Many of these laws specify exclusive municipal or hauler ownership of curbside materials. Despite the cost and difficulty in enforcement, anti-scavenging laws are thought to be effective because occasional token fines and public monitoring of offenders have discouraged the scavenging. Anti-scavenging laws are seen as essential during price surges for newspaper.(15)

Some municipal laws state that municipal or licensed haulers own curbside materials on refuse and/or recyclables collection days. Therefore, charity groups can collect newspaper from porches or can collect from curbside when refuse crews are not operating. That is, municipalities with source separate collections, may still allow charity newspaper drives.

B. Set-Out Location:

Where yard pickup of wastes was previously permitted, source separation programs are often accompanied by laws designating set-out at curbside to cut collection time. There are other laws that apply only indirectly to source separation, such as the mandatory bundling of newspaper where participation itself is voluntary. Only publicity given to such laws would effect higher participation.

At another level there are laws mandating or encouraging municipal participation in regional schemes. For instance, under California's new comprehensive waste management legislation, towns using regional disposal facilities are exempted from a dump surcharge if they have a source separation program. In the planning area around Boston, Massachusetts, a new regional plan mandates source separate reclamation programs in towns

wishing to participate in a regional refuse derived fuel scheme. (The loss of BTU's from source separated, sold paper is not viewed as a problem.) In both States there are guaranteed markets for reclaimed materials and time-tested source separation programs.

13.6 Summary and Conclusions

There are wide differences of opinion about the effectiveness and public acceptance of laws mandating source separation. Early comparative studies point out that variables other than laws are more responsible for program success. Despite pressure for laws from some interest groups, there is municipal hesitancy to legislate mandatory source separation until programs are well underway.

There are at least three prerequisites to legislating household source separation:

- vigorous program promotion
- reliable and convenient collection operations
- ensured market(s) for materials

When these three factors are in place, a mandatory bylaw could boost participation and recovery. (But if these three factors are in place, a bylaw may not be necessary. Note claims of high participation in several voluntary programs cited in this report: 50-80% in NVBO-serviced apartment blocks in Washington, D.C.; (16) 50% in Downey, California (17) and 65% in San Luis Obispo, California. (18))

It would be instructive if two similar Ontario communities with source separation programs were to be tested for the effect of a mandatory bylaw on recovery, participation and diverted disposal rates. One community could be approached to enact a bylaw and another would act as a "control group".

Other legislation affecting source separation and enacted elsewhere, includes laws related to 1) anti-scavenging, 2) set-out placement at curbside and 3) responsibilities of local governments to include source separation among disposal options.

The first two should be included in an Ontario implementation manual as recommended local legal supports for source separation programs. The third could be considered at the provincial level as part of a comprehensive waste management policy.

SECTION 14

STANDARD CONTAINERS FOR HOUSEHOLDS PARTICIPATING IN SOURCE
SEPARATION PROGRAMS - AS A SPECIAL CONSIDERATION14.1 Introduction

Twine, grocery bags, reused cardboard boxes and regular refuse cans are normally used for the curbside set-out, or delivery to centres, of source separated recyclables. Bags and boxes are readily available and costless to householders. Twine is low cost, and garbage cans, if used, would have to be considered costless for source separation. Despite these advantages, some source separation proponents recommend the use of special standard containers. This section deals with the functions, designs and merits of special containers for participating households.

14.2 System Considerations

The following points underline the fact that standard household containers cannot be considered apart from several other components of source separation system design:

A. Household Preparation and Participation:

It may be surmised that a special container adds to the convenience of sorting and storage, and therefore serves as an inducement to begin and/or sustain separation activities. It should be noted that in this research, no data were found on the relationship between containers and participation levels. Few programs examined employ containers, and among those that do, other variables related to participation could not be held constant in order to assess the effect of special containers.

B. Publicity:

Apart from acting as internal household reminders, containers designed for curbside collection systems may be powerful neighbourhood publicity tools when set at curbside on collection days. Neighbours would feel pressure to add their containers to the line-up on the street.

C. Stage of Storage:

Containers are being used and considered for three, not mutually exclusive, stages of storage for source separation: for kitchen segregation and storage; for secondary storage in garage, porch or yard; for curbside set-out or transportation to collection centre. Containers designed for the second and third purpose are usually too large for the first purpose. Containers that go through the materials handling flow are not usually considered desirable for kitchen use.

D. Total Program Cost:

Regardless of purpose, container cost is related to program budget. Kitchen or secondary containers may be provided in order to increase participation, or to save collection time by identifying recyclables for collectors. These advantages have to be weighed against increased program costs if containers are provided for "free".

E. Fractions Collected - Kind, Number and Comingling: The necessity for, and the design of containers depend on what materials are collected. Containers are of little concern where only paper is collected, except in certain curbside program locations with predictable rainy periods. A single container unit is sufficient for one fraction, or for several fractions that are comingled when collected at curbside/dropped off at centres. A set of containers, or a compartmentalized container, may be considered for multi-material programs where household comingling is not practiced. An alternative in the latter situation is to provide an undivided tub, with instructions for dividing materials into separate bags within the container.

F. Container Size Factors:

Local recyclables generation rates and frequency of curbside collection are determinants of container capacity. Containers designed for secondary storage can be larger than containers designed for kitchen use.

G. Processing and Materials Buyers' Specifications:

As implied in E., stages following collection in the materials flow, affect container design. In a glass collection program, an undivided container could be provided under two circumstances: when markets are available for colour-mixed glass (the consuming industry either can use colour-mixed glass or has a colour-sorting facility); when markets are not available for colour-mixed glass but colour-sorting is performed at the program sponsor facility or by an intermediate processor. An undivided container could be provided for any combination of glass, metal, or paper collected, when separation is performed at sponsor facilities or by an intermediate processor.

H. Collection -- Frequency, Simultaneity with Refuse, and Labour Productivity:

Special containers for set-out may be considered for five reasons in addition to publicity and participation value:

- When non-paper recyclables are collected on the same day as refuse at curbside, special containers would aid collectors in identifying recyclables and would help researchers in monitoring recyclable set-outs.

- Standard containers could save collection stops for small amounts of materials if householders were educated to put them out only when full.
- Large containers for set-out that are also used for secondary storage could lessen the need for frequent pickups, i.e. monthly instead of weekly.
- When compartmentalized vehicles are used for multi-material collection, special containers would lessen contamination at the point of loading because contents would be known to collectors.
- Durable containers could reduce the problems associated with paper bags and boxes-- containers which deteriorate in rain and stick to snow resulting in scattered materials. This litter is a public relations problem, is an irritation to collectors and increases collection time.

Considering the above five reasons favouring special containers, there may be other means of solving these problems. Stickers could identify conventional refuse bags or cans used for recyclables, or collection days could be different for recyclables and refuse. Bother-some small amounts and costly frequent collection could be obviated by educational means. Only the fifth example has no alternative solution other than cancellation of separate pickup in inclement weather.

The advantages of containers to collectors may be off-set by increased collection time (if containers have to be replaced at curbside), unless containers are durable enough to be pitched back onto properties, or unless containers are interchangeable among households. It should be noted also that if containers are not replaced at curbside (that is, if an empty container from a previous stop is substituted for a full one at the following stop, thus saving collection time) substitute containers would not normally be publicly acceptable for kitchen segregation for sanitary purposes.

14.3 Examples of Standard Containers Provided to Participants

Following are some examples of containers employed in existing and proposed source separation programs:

- A. In Sacajawea and Seattle, Washington, plastic bags are supplied to residents during rainy winter months to keep newspapers dry on pickup days.(1)

B. In a new program for Seattle, Washington, for participants in certain pilot areas, two special potato sack-type bags are used for storage and set-out of mixed metals and colour mixed glass. Equipped with a drawstring and somewhat elastic, the bags take up a 5' x 5' area in garage or basement and are large enough for storage between monthly pickups. In the container train collection system, collectors work as follows: pick up both bags at each stop, place the glass bag into the glass bin, empty the contents of the metal bag into another bin, stuff a new bag (for glass) into the empty metal bag, return both to curb, pick up bundled newspaper and remount the trailer. The glass bag is not emptied until it arrives at the processing site for colour sorting and the setting aside of returnable and reusable bottles.(2) (See Appendix 5 for revised bag system.)

C. In Nottingham, New Hampshire, separation is mandatory and materials are delivered primarily by householders to a town collection/incineration centre. Some 1200 households have been supplied with a set of containers labeled for contents and preparation instructions. Initially two design choices were offered: a set of three standing metal cans for refuse, bottles and cans, leaving container choice for paper up to the resident, OR a stacking group of four wooden boxes, with space for the insertion of items into each category (metal, glass, paper, refuse) with a choice of two widths. These containers were intended for in-home use but residents who do not bring recyclables to the centre in bags, cartons or trash cans, often use the provided containers for transport.(3)

More recently, a three-unit stackable version has been developed for cans, glass and refuse. Paper is usually piled separately but could be inserted into a fourth unit. These blow-molded, high density polyethylene units consist of a container and its snap-on base. The base permits one container to be securely positioned on top of another. Both base and container lip are cut out so that materials can be inserted without moving the next container. The "high-rise" units are snapped apart for transportation to the collection centre and nest together for storage. The smaller units stand 11 7/8" tall with a 6.75 (U.S.) gallon capacity. The larger units stand 17 5/8" tall with a 10.5 gallon capacity. The normal combination is one large unit for refuse and two small units for cans and glass. This combination stands 41" high with a 24 gallon capacity and requires a floor space area of 17" x 15.5". Until patents are obtained and rights are released to commercial distributors, limited production runs are available at cost for \$2.42 (small unit) and \$3.12 (large unit).(4)

D. In Wabash, Indiana, separation is voluntary and materials (paper and glass) are set out for collection by the Isaac Walton League, a naturalist group. For three colours of glass, the group sells a set of three colour-coded containers for \$7.50 and charges homeowners nothing for pickup.(5)

E. In Cambridge, Massachusetts, separation is voluntary in a low-income public housing program run by Residents Recycling, a group devoted to youth employment. Buckets are distributed to tenants who agree to separate tin, aluminum and paper from trash. These comingled recyclables are picked up by appointment.(6)

F. In Kirklees, U.K., separation is voluntary in the Oxfam WasteSaver Project. While residents use no special container in the home, a secondary storage device for porch or yard was initially provided by Oxfam. Called the "Dumpy", the tubular steel stand carries four woven polypropylene, colour coded sacks. Waste is sorted into four categories as follows: newspaper; mixed waste paper; jumble, clothing, rags, toys, books, non-ferrous metals, bric a' brac, etc.; glass, tins, plastics. The Dumpy is patented, has a capacity of over eight cubic feet, is weatherproof, attractive, costs about \$5.00 per household, and was distributed to 6,000 participants who agreed to use it. The two-minute handling time for collection crews to replace the sacks, and a 60% hike in Dumpy purchase price, were the two cost factors which led to discontinuation of the container. Research is underway to assess householder response to the container.(7,8)

G. In Kelowna, British Columbia, the Kelowna Recycling Society provided free containers to 315 homes in a source separation pilot program. Made of brightly coloured corrugated plastic, the non-partitioned tubs cost \$4.50 each, and hold three grocery bags for glass, newspaper and brown kraft bags. The purpose of the containers is three-fold: to help collection crews to identify recyclables collected on the same day as refuse; to advertise the program on each street, assuming that householders will be induced to set out their yellow tub along with everyone else; and to instill confidence in the program through use of standard containers. A 75% participation rate is claimed for the program.(9)

H. In University City, Missouri, yellow plastic containers are provided to residents for newspaper storage, and set-out at curbside. The container is designed to keep newspaper dry on rainy days and to store a two-week supply of a daily paper.(10)

14.4 Other Container Designs

A container developed by a New England non-profit company was based on the concept of three rectangular waste baskets joined together and lined with paper bags. The concept was sold to a U.S. catalogue outlet for distribution, but was dropped because of low sales.(11,12) Another device, the "Easy Bundler", which helps tie a twenty-five pound bundle of newspaper and acts as a storage rack, sold for under \$5.00 in 1974. Marketed by a U.S. mid-west company, the line has been discontinued.(13)

14.5 Research on Containers in Ontario

A summary of recommendations made for existing Ontario source separation pilot programs in a consulting study may be helpful. As a result of focus group discussions, authors conclude that programs should "give people ideas for containers, so they can provide their own, to their liking, at little or no extra cost".

There was general agreement about the following aspects of container design and distribution. Containers should: not be given away by government but rather be marked as government property; not be given unless solicited; be rectangular; have handles for carrying; have removable lids to safeguard against children and dogs; and be free-standing.

Apparently as a result of differences in experience with source separation, there were marked differences in opinion between people who already separated materials for recycling and those who did not. Separators wanted stacking containers for storage away from the kitchen in garage, porch or basement. They wanted large containers that could be used both for this secondary storage and for placement at curbside. They did not want containers designed for lining with bags because paper bags would break with moisture from rinsed, but undried, recyclables. They knew that plastic bags were not biodegradable. Separators did not think containers were necessary for newspaper, and generally thought that free containers were a waste of taxpayer dollars. Separators were not interested in purchasing containers.

On the other hand non-separators wanted a single sectioned compact unit for kitchen storage to minimize work. Expecting that weather and collector rough handling would damage containers, they saw containers for inside use only. They preferred containers meant to be lined with bags (as a reuse for grocery bags) and they were interested in a container with hooks to keep plastic grocery bags open. They also thought that a container would be useful for newspaper.(14)

14.6 Alternatives to Containers

Except for the above examples, and a few groups that wish they could afford to provide containers (15,16), most source separation program sponsors are not interested in providing containers. The tendency is to encourage self-sufficiency on the part of participants in designing their own in-home techniques with bags or boxes. A recurring comment during interviews and in written responses, was that a container cannot make a recycler out of someone who fails to be motivated by other publicity measures.

In the carefully streamlined Marblehead, Massachusetts test program, special containers have not been recommended despite experience with problems which special containers might solve. Weather-ruined boxes and bags, are a recurring problem, as was the identification of recyclables for crews. As a solution to the latter, recyclables are now picked up on a different day from the regular refuse pickup. (17)

In Waterbury, Connecticut, special containers are not being considered until it is decided whether to expand a pilot program to full scale. For now, comingled recyclables placed in regular refuse cans for backyard pickup are identified by stickers on cans. But residents have not been consistent in placing recyclables in marked containers so collectors remain confused. (18)

In Sacramento, California, adhesive tags are envisioned for a proposed multi-material curbside collection program. In the multiple pass collection schedule, different stickers would be applied to regular refuse cans (containing recyclables) each week by collection crews. The stickers would notify residents of the date and fraction to be picked up in the following week. For the twelve-week pilot period, the cost of the adhesive tag system is included in a total publicity budget of \$8,335.00 or \$1.00 per household (1977 U.S. dollars). (19)

14.7 Summary and Conclusions:

Special container designs vary from simple bags and buckets to more sophisticated compartmentalized tubs and stacking units.

These special containers for householders participating in source separation programs are sometimes provided for stages of storage which affect design: for kitchen storage, for secondary storage in yard, basement or porch, and for curbside set-out. Other factors which affect design are container cost, kind and number of fractions collected, stipulations of materials buyers, program processing activities, local weather conditions, frequency of collection, and quantities recovered by householders.

Special containers not only have merits for the convenience and inducement of householders, but also have advantages for collection crews. Recyclables are easily contrasted from refuse when collections are on the same day, and the irritation of broken bags, bundles and boxes is averted. With proper container design, recyclables are better protected, litter is minimized and small-volume pickup stops can be reduced. These advantages to collection crews can be off-set by the requirement to replace the container at curbside, unless an empty container from one stop is substituted at the next stop, or unless the container is durable enough to be thrown from the collection vehicle onto a property.

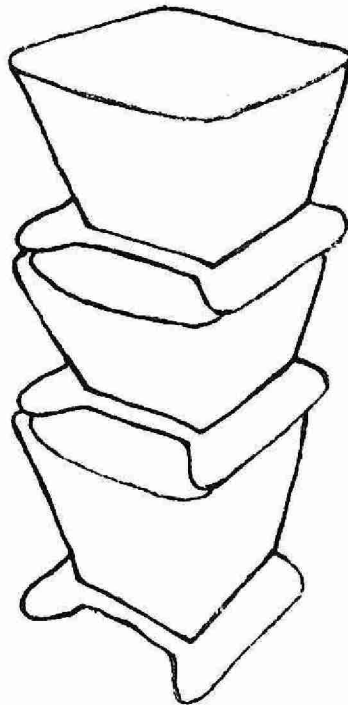
The most significant contribution of a special container may be its powerful advertizing impact when placed at curbside. Containers, however, are expensive to the sponsor of a source separation program, unless they are sold to householders. Except for the one example of container sale in this research, "free" containers are provided by groups who are given grants to do so, or by municipalities which are operating limited test programs.

As implied by previous Ontario research and as recommended by many ecology groups in the spirit of "make do", most source separation programs do not perceive special containers to be a priority.

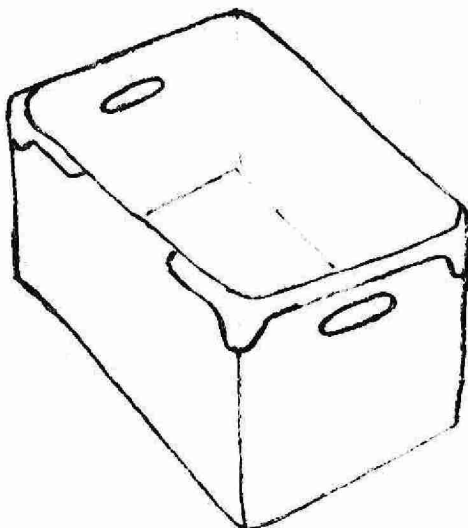
In future Ontario pilot programs, experimental and control groups within test areas could be used to determine whether special containers are related to increased participation when all other system design variables, especially householder preparation requirements, publicity, and collection frequency, are held constant. How containers impact on other system design aspects (cost, optimum collection frequency, labour productivity, collection time, contamination, publicity requirements, and so forth) could be tested by the repeated use of two test groups as above, in a number of different programs.

Regarding other initiatives in Ontario, the Glass Container Council should be contacted for an evaluation of glass gobblers used in the Borough of Etobicoke curbside glass collection. Results of a container experiment carried out at CFB Borden in early 1979 under federal auspices, should be examined by provincial authorities. The Waste Management Advisory Board should have input into the planning process related to the proposed community of Woodruffe. This new community presents an opportunity to design a comprehensive waste management system including household storage designs for source separation.

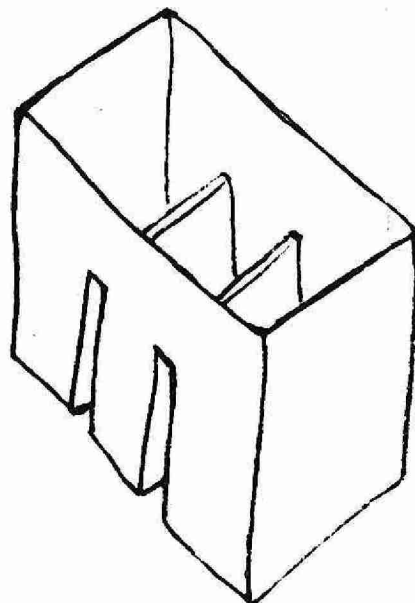
Exhibit 2: Illustrations of three Special Containers



Stacking, Nesting
Container Developed
by "Recycling &
Conservation" for
employment in Not-
tingham, New Hampshire
(see 14.3.C in text)



Non-Partitioned
Container Developed
by "Kelowna Recycling
Society" for employ-
ment in Kelowna,
British Columbia
(see 14.3.G in text)



Partitioned Container
Developed by
"Recycle-It" for
Experimental Sale
through "Sears"
catalogue (see 14.4
in text)

APPENDIX 1

Place: Helena, Montana - A Municipal Newspaper Collection Program

Population and Households (Served):

26,000 residents inside city limits; 7200 households in city.

Residential Waste Generation:

12,810 tons residential waste per year (residential waste an estimated 61% of 21,000 tons disposed annually; all refuse vehicles weighed at disposal site.)

SES: "Well educated"; "well off".

Refuse Collection System:

- Residential collection once per week by municipality for a mandatory fee of \$4.00 per household.
- Commercial and apartment buildings serviced mostly by municipality (a few by private contractor).
- Municipal fleet of 4 rear-loading packers (plus one reserve vehicle) and 1 front-loading packer; a total of 6 trucks.
- 2-man crew on each truck (cut back from 3-man crews in March, 1978), total of 10 crew persons.
- City furnishes plastic garbage bags for residents in order to cut collection time (no cans have to be replaced at curbside during collection.)

Separate Collection System:

Rack approach; newspapers and refuse picked up simultaneously.

Administrative Mode:

Program comes under jurisdiction of City's Public Utilities Department, responsible for waste management, but full-time coordinator "hired" for one-year to plan, implement and supervise early operation of source separation program. (Paid by a federal job-creation subsidy program (CETA), coordinator's wage not presently allocated to source separation budget.); attempt will be made in second year of operation to isolate administrative costs.

Method Description: Newspaper only

- (1) Startup Animation Process
Date started: March 1, 1978
Date ended: Still operating

Motivational Impetus:

- 1977, representative of a national conservation organization (National Wildlife Federation) lead workshops on solid waste management in Helena.
- No local waste disposal crisis but NWF staff aroused concern of Helena Citizens Council, an environmental group; "Solid Waste Task Force" resulted.
- January 1978, Task Force tabled feasibility study for a newspaper recovery program (Study analyzed newspaper availability, markets, shipping options, collection method, costs and promotional strategies).
- Public servants impressed with analysis and elected politicians sympathetic; newspaper prices lucrative then.

Publicity:

- Ambitious public awareness campaign (initial and ongoing) proposed: extensive use of media, liaison with community groups and service clubs, integration of recycling into school curricula, distribution of printed materials to residents.
- Projected budget of \$475 for startup publicity; covered out-of-pocket costs, and assumed substantial "free" volunteer time input.
- Actual startup publicity resembled proposed, but ongoing publicity minimal, with exception of one leaflet distributed (by subsidized CETA staff when delivering plastic garbage bags) to residents during first year.
- \$1000 actually incurred by City in first year publicity; excludes volunteer labour and flyers donated by NWF.
- Projected future ongoing publicity cost of \$500 per year.

Funding Sources:

All planning done by Volunteers and "as a service" by public officials; publicity costs and coordinator's wage not allocated to source separation; therefore no funding required.

(2) Collection:

Householder Preparation Requirements:

Bundle newspaper with twine, or place in brown paper grocery bags.

Equipment and Manning:

- Rejected two options: monthly collection by separate packer and weekly collection by small pickup truck; instead, entire packer fleet fitted with racks; no special vehicles or extra crews required.

- Total of 11 racks made in municipal shop, for a total labour and material cost of \$500; includes installation; average rack cost of \$45.50.
- Each rack custom designed for specific truck; front loading packer with one rack mounted behind cab, difficult to load because of rack height; rear loading packers with 2 racks, each axle-mounted, easy to load.
- Racks rarely fill before packer body, so no containers positioned on route for overflow, no extra auxiliary transfer vehicles necessary, and no "dead runs" made to off-load newspaper when packer body not full.

Method:

Crews collect bagged and bundled newspaper set-outs and place on racks during normal weekly refuse collection on both residential and commercial routes; off-load by heaving paper from racks directly into semi-trailer at landfill site.

Recovery:

208 tons collected first year; estimated recovery rate 34.6% based on in-depth research into newsprint availability (newspaper waste generation and composition unknown, so availability estimated on basis of local and regional newspaper production of 600 tons per year, down from original estimate of 900 tons per year).

Seasonal Variations:

None identified; recovery not reduced in winter.

Costs:

No operating costs allocated to source separation; plan to do time studies on load/off-load time. Note: Source separate collection started one month after crews cut from three down to two persons; has been some crew overtime, but incremental time required for newspaper collection cannot be isolated, i.e., cannot compare 3-man crew - no paper pickup program with 2-man crew - paper pickup program.

(Officials realize that the rack system operates economically at existing recovery levels. If recovery jumped, diseconomies would result from "dead runs" to the landfill site by trucks full of paper but not full of refuse, and from crew overtime. Consideration would then have to be given to collection by separate truck, or to the addition of extra vehicles for the transfer of paper from on-route collection vehicles to the trailer at the landfill site.)

Participation:

Estimate not available; set-outs not monitored.

(3) Processing:

None carried out other than quality control of labourers who pull off obvious contamination. Quality of material acceptable to buyer but loose paper causes handling problem throughout material flow.

(4) Transportation:

Mode and Equipment: Semi-trailer permanently stationed at landfill site; newspaper loaded directly into trailer from collection vehicles; trailer hauled by cab, and holds about 14 tons of stacked newspaper.

Distance to Market: 93 miles away; 13 hauls in first year.

Shipping Cost: As transportation provided by paper buyer, costs reflected in paper purchase price f.o.b. Helena.

- First year, trailer provided at no additional charge; second year, Helena pays 50% of fixed trailer costs (includes rental, licensing, and insurance, but not driver wage, fuel, or maintenance) which amounts to cost of \$10 per ton off purchase price.
- Related shipping cost, not allocated, of 3 person hours (CETA) per week to stack paper in trailer in order to increase shipping volume per load; stackers also box loose paper under new contract terms.
- No storage space available for paper and city cannot haul to market for less than \$10/ton, so trailer option viewed as suitable (stackers' wages subsidized).

(5) Marketing:

Price: First year \$47.50 floor price with escalator clause, but price never rose; second year, \$15 floor price with no escalator clause (rejected one bid offering 150% of San Francisco Official Board Market, currently \$12, f.o.b. plant; would have grossed \$18/ton but city would have had to provide transportation), minus transportation charge, for \$5/ton net.

Buyer & End Use: Robinson Insulation Company, Great Falls, Montana; cellulose insulation.

Contract Terms: Highlights -

- First year contract: price f.o.b. Helena, trailer provided, and full transport service (as above); if buyer did not

pick up trailer within 3 days of phoned request, vendor entitled to \$47.50 per ton disposed after trailer full (but clause never invoked because city found storage space when buyer pickup overdue); buyer can refuse wet paper.

- Second year contract: price f.o.b. Helena, transport service, and 50% of fixed trailer costs (as above); no revenue provision for amounts disposed due to late pick up of trailer; buyer can refuse wet paper and loose paper; 90 day termination notice from either party wishing to break contract.

Alternative Markets: Several dozen markets identified but choice of market limited by two factors - buyer must provide trailer at landfill site and must provide transportation to market.

- (6) Disposal of Residual: 208 tons recovered first year, left 12,602 tons of residential waste requiring disposal by landfill (diverted disposal rate of 1.6% residential waste); no direct savings estimated, but diversion seen as extending site life in long term.

Brief Summary Comment:

The Helena program is significant for several reasons. First, the feasibility study done by local citizens in cooperation with public officials, is an excellent example of the approach that should be taken by a community in planning a source separation program. While the statistical predictive measures used are not sophisticated, the report leans heavily on engineering results obtained from other program evaluations. The report illustrates the weighing of alternative collection methods, haul options and market choices, leading to the development of a system suited to local conditions.

Second, the Helena collection system design may be applicable to small Ontario communities in proximity to paper mills which can use waste newspaper as a furnish component. (Normally, single-material source separation programs, partly motivated by high revenues, are considered lacking in an overall waste management perspective; however, there are Ontario communities in which markets for glass and tin are absent, or at least not within affordable haul distances.) In such areas, single-material newspaper collection programs might make economic sense and have conservation education impact.

The Helena-type packer rack collection method has low startup equipment costs, requires little alteration of householder garbage set-out behavior, does not require heavy recovery in order to operate economically, and is compatible with existing refuse operation equipment and crews.

Third, elected politicians in Helena recently (April, 1979) voted to continue the program under adverse market conditions. 1979 contract prices plummeted to one third of 1978 prices, and first-year labour subsidies are being withdrawn. (CETA funds workers for one year, after which employers must pick up the tab). This financial crunch has stimulated a greater cost-consciousness in Helena. Officials will be logging vehicle and crew performance and will start isolating buried program costs. This atmosphere of combined political endorsement and cost-mindedness, appears to be worthy of emulation.

Contact Person: Reports and further information are available from Helena Public Utilities Director, Mr. Dick Nisbet at (406) 442-9920 Ext. 34.

Reference: See bibliography for annotation of Solid Waste Task Force's initial report entitled, The Potential for Newsprint Recycling in Helena.

APPENDIX 2

Program: Kelowna Recycling Society (KRS), operating a multi-material source separation program fed by drop-off and pickup collections.

Location: Kelowna, British Columbia

Population and Number of Households:

51,955 city dwellers and 15,000 additional residents in surrounding area (1977); 11,460 households (1971 census). 300 households serviced in curbside collection program.

Residential Waste Generation:

Residential figure not available from KRS which estimates 1,000 tons per week total municipal waste (but precise figure unknown due to volume basis of municipal estimate and unwillingness of private waste haulers to provide data).

SES: Average annual income of \$8,422 (1974 taxation statistics); middle to upper class in curbside area.

Regular Refuse Collection System:

By commercial waste haulers under contract to municipality for once per week residential service.

Separate Collection System:

Combination of drop-off and pickup collection from both residential and commercial sources of recyclables (see "Collection"). KRS residential collection includes:

- Curbside service in small pilot area; single pass, weekly collection
- Mobile depot service in scheduled locations
- Assisted drop-off centre at KRS handling station during hours of operation
- Unassisted drop-off bins outside handling station for after-hours patrons
- Weekly pickup from 22 apartment blocks.

Administrative Mode:

Evolved since 1972.

- Started in 1972 as newspaper and glass depot, run for Boy Scouts by local chapter of Society for Pollution & Environmental Control (SPEC), a province-wide umbrella group with 18 branches, many of which operated "recycling" projects in early 1970's.

- When volunteerism dropped off, depot taken over in 1973 by Okanagan Recycling Ltd. (ORL), a private family business motivated by environmental zeal.
- When ORL experienced severe financial and management difficulties, a new structure was created in 1975. The local SPEC branch incorporated as the Kelowna Recycling Society (KRS), ORL retained ownership of capital assets transferred to KRS, and ORL owners became employees of KRS. Thus a private company operates the program of a non-profit corporation. (New structure maximizes fund-raising opportunities.) KRS became a member of the Recycling Council of British Columbia (RCBC), a service organization for its community based source separation program members.

Method Description:

(1) Startup Animation Process:

Date Started: In 1972, as depot for glass and newspaper; in 1973, as ORL depot plus pickups from commercial sources; in 1975, as KRS with past operations augmented by mobile depots; curbside pilot added in 1978.

Date Ended: Still operating (brief stoppage of program in 1976 during low newspaper price period).

Motivational Impetus: Combination of forces leading to present program:

- Early history as Scout fund-raising project supplemented by SPEC environmental zeal
- Personal commitment of ORL family to combine environmental perspective with business
- Influence of RCBC as sustaining force
- Municipal interest in potential of KRS during landfill search in 1976 (disposal crisis lead City to take a more supportive role by donating warehouse space to KRS, and granting a payment to KRS per ton diverted from disposal).

Publicity: For curbside program, publicity through heavy press coverage, distribution of mayor's letter of endorsement, and delivery of special containers for setting out recyclables. Education a high priority with KRS and following tactics used on ongoing basis:

- Visits to schools
- Speaking engagements at club meetings
- Displays at fairs and public meetings
- Press articles
- Radio interviews

- Dialogue with, and briefs to, local government. Costs not allocated separately except for curbside program (report not yet available on publicity costs and results of questionnaire). Public education carried out by KRS/SPEC volunteers, ORL manageress, and Canada Works grant employees. Regional government grants in 1975 and 1976 (\$1,000 each year) for public education.

Funding Sources: No funding required during first volunteer phase. ORL owner obtained personal loan of \$12,000 in 1973 to purchase equipment and finance working capital requirements for expansion into pickups from commercial sources. All other funding would be considered operating funds rather than startup funds, i.e., 1978 Canada Works labour subsidy enabled expansion to curbside collection but did not finance system design or provide startup capital. Following is an approximation of KRS 1978 operating revenues, excluding value of donated site (from City) and labour (from probationers assigned to KRS and from volunteers):

Approximation of KRS Operating Revenues for 1978

Category	Amount
Sales of recyclables ⁽¹⁾	\$40,000
Government Aid	
City of Kelowna diversion grant ⁽²⁾	15,000
Province of B.C. grant ⁽³⁾	10,000
Federal gasoline tax rebate	230
Interest income	200
Membership dues	10
Total Operating	65,440
Canada Works grant (non-recurring labour subsidy)	44,000
Total Revenue	\$109,440

- (1) Estimated at average price of \$40/ton X 1000 tons/year
 (2) Allowable \$17/ton, to maximum of \$15,000/year
 (3) Matching funds to maximum of \$10,000/year, due to municipal grants (diversion grant and value of donated site)

(2) Collection

Householder Preparation Requirements (Residential):
 Contaminant-free newspaper, bundled or packed

into brown grocery bags. Clean, contaminant-free, colour mixed glass desired; no specification for kind of containerization to be employed for glass by drop-off patrons, but glass to be set out at curbside in brown bags. Special container for setting out recyclables provided gratis to all 300 homes in curbside pilot area (a yellow corrugated plastic tub with space for three materials: bundle/bag of newspaper, bag of brown paper bags, bag of glass). Purpose of special container is to advertize program and inspire confidence in program.

Equipment & Manning:

- For residential curbside, one-ton van (equipped with bins) used in Glenmore collection area of 300 homes. KRS considering expansion of curbside collection to other neighbourhoods; would therefore cut back Glenmore to bi-weekly collection in order to serve greater area in same time frame, but cut back would necessitate larger truck, assuming a two-week accumulation of presently recovered amounts.
- For all collections, KRS vehicle pool includes following trucks at 1978 acquisition costs specified (trucks purchased second-hand and owned by ORL):

4-ton diesel stake truck	\$1,500
2½-ton van with power tailgate	1,200
1-ton van	1,500
½-ton pickup	1,400
½-ton tradesman van	<u>3,000</u>
	\$8,600

- For overall collection, KRS employs two truck drivers, currently assisted in collections by Canada Works staff and by various volunteers, including referrals from a mental health unit; therefore, collection time varies. Residential curbside crew of three spends about one and one-half hours on route; time increased if must pick up litter caused by untied news, time decreased if collect simultaneously from both sides of street.

Method, Recovery, Schedules, and Distance (By source of material; availability of information varies):

- Commercial pickups: total of six pickup routes (four area routes and two special categories of suppliers). Type of truck and crew sizes vary. Materials include mostly corrugated, plus some newspaper and glass. Recovery ranges from 800 to 2000 lbs. per route-day. Schedules vary: daily, every other day, weekly, summer only, and as required. Six routes range from three to nine miles each, taking from one and one-half to three hours each, to collect from total

of 137 business establishments. Recent addition of pickup service for banks and printing companies brings in two tons ledger and six and one-half tons newspaper per month.

- Apartment collection: total of 22 apartment complexes, serviced weekly, yields weekly recovery of 3,000 lbs. newspaper, 1,000 lbs. glass and 200 lbs. corrugated.
- Curbside collection from single family dwellings: (Initiated in order to increase throughput, allow monitoring of publicity effectiveness and costs, and boost participation through convenience.) Collectors pick up special containers from curbside, empty bundles/bags into bins on van, and return same empty container to curbside at each participating household. Average weekly recovery is .83 ton of material: 1,045 lbs. newspaper, 554 lbs. glass, and 52 lbs. brown bags. Weekly pickup schedule (Wednesday morning), on same day as refuse collection. (KRS feels weekly schedule too frequent and is considering cutback to every-other-week schedule as noted above.) Collection distance, including travel to route, is nine miles, but when KRS crew does not collect from both sides of street, total route distance increases to 14 miles. Time approximately one and one-half hours, depending on crew performance. Route includes one small store (corrugated and news), and one apartment block. Bins off-loaded from van by forklift at KRS handling site.
- Mobile depots: trucks, carrying bins, dispatched to specific outlying communities in region. Recovery is 1.5-2 tons/week. Trucks park at each scheduled location for period of two hours, usually on Saturdays. This service viewed by KRS as a responsibility due to receipt of funds from Region, but yields a low return for effort.
- Other sources of recyclables: Drop-off
 - Deliveries of newspaper and glass from sporadic drives held by charities, yields 20 tons/year
 - Deliveries of newspaper and glass from general public during and after hours
 - Deliveries from post office; yield 6.5 tons shredded news and two tons excess flyers per month
 - Corrugated and glass collected by "recycling" group in nearby Princeton, B.C. (population 1,300) shipped through KRS.

Seasonal Variations: None noted, except for special daily pickup of corrugated from meat packing houses in summer only.

Costs: Except for capital equipment values, costs not allocated separately from other activities, i.e., processing, shipping to market, etc. Report in preparation by RCBC (Enertask Consultants), on curbside pilot program, will compile hard data being gathered weekly. KRS aiming for "break-even" expanded curbside program by November, 1979.

Participation: Preliminary data on curbside pilot program. Participants defined as households which have set out any fraction two or more times over monitoring period of 10 weeks. Participation rate of 85%. (Enertask report expected to tabulate participation rates by various fractions.)

(3) Processing/Handling:

For total annual 1978 throughput of 573 tons currugated, 362 tons newspaper, and 123 tons glass.

Site: Current site (fourth site since 1972) is a municipally owned compound, valued at \$5,000 rental value per year, rented to KRS for \$1,000/year. Measures 13,089 sq. ft. with an open yard and parking, plus sheltered spaces for different functions as follows:

KRS Handling Station

Activity/Function	Approx. Space (sq.ft.)
newspaper storage	2,352
glass storage & processing	900
ledger storage & baling	1,311
paper sorting, storage, shredding, & baling	1,388
general storage	1,023
general baling	434
bale storage	621
bottles & jars for resale	434
office	176
yard & vehicle parking	4,550
Total	13,089

The site has a 12' wide loading gate and a 14' wide general access gate. As City plans to use compound again, a newly constructed site is in design stage.

Equipment: (1978 acquisition costs follow items described) For processing: three balers (\$3,000, \$5,000, \$8,000); a paper shredder with one ton/hour capacity (\$7,000); a glass crusher with 600 bottles/hour capacity (\$500). For handling: a forklift with two-ton capacity (\$5,000); a pallet jack with one-ton capacity (\$100); a heavy duty handcart (\$40); banding equipment

(\$270). Total processing and handling capital cost of \$28,910.

Method:

- Corrugated: received in various forms (flattened loose, unflattened, small bales). Small bales opened for contaminant removal and density improvement; whole boxes flattened. Once all boxes flattened, they are fed into one of two downstroke balers. Balers yield total of seven 800-lb. bales per day. Bales moved to storage area before shipment in 20-22-ton loads.
- Newspaper: received bundled, bagged or loose. Unbundled paper is bundled and stacked, or placed for storage in used windshield crates, recently replaced by stackable and more durable apple boxes. Newspaper not baled.
- Ledger: first sorted for contamination, then shredded if confidential, or placed directly into pivot stroke baler.
- Glass: half of throughput received from commercial sources, bottles generally clean and in original cases; other half from residential sources and more contaminated. Following contaminant removal, glass crushed in glass crusher mounted on a 45-gallon drum.

Note: Materials transferred internally in bins/crates by (2) manual and (1) mechanized trucks without use of conveyor belts, hoppers, or front-end loaders.

Manhours: Seven staff assigned to processing/handling: two baler operators for corrugated, one ledger paper processor, one glass processor, two general material handlers and one yard/production foreman. No specific information on manhours other than implication that the two corrugated baler operators work to full capacity (seven 800-lb. bales/day from low throughput balers) and that glass processing is excessively time-consuming: contaminant removal takes four to six hours/ton and crushing takes up to one and one-half hours/ton. Referrals from a legal offender program are usually assigned to glass processing.

Costs: Except for capital equipment values, processing costs not allocated separately from other activities.

Product Quality Description: Apparently suitable to purchasers.

(4) Transportation:

Mode, Equipment, Distance and Cost: Newspaper and corrugated shipped overseas in rented overseas container, in 20-22-ton loads at estimated shipping cost of \$15-17/ton. Glass hauled in a

four-ton dump truck to glass plant, a one and one-half hour driving distance. Costs of \$12 for driver and \$15 for gas, are shared with Princeton "recycling" group in a joint glass haul arrangement. (Capital truck cost of \$3,500 paid by RCBC for member group glass hauling.) A five and one-half-ton load (excess truck capacity) is shipped for less than \$30/load. Information on ledger hauling not specified.

(5) Marketing:

Price: November 1978 fibre prices were \$45-50/ton for newspaper, \$70/ton for corrugated, and \$90+/ton for ledger. Glass price for same period was \$37/ton, up from \$15/ton in 1975.

Buyer: Orient overseas buyers for newspaper and corrugated, arranged for KRS by RCBC for membership donation of 10% of resulting reserves. Glass bought from KRS by Consumers Glass without RCBC "brokerage" role.

End Use: Not specified for fibre; glass cullet recycled into new glass products.

Contract Terms: None specified. Previous (1977) contract, for news sales to local cellulose insulation maker, broken by buyer.

Alternative Markets: Not being investigated for glass. Local cellulosic insulation manufacturer being assessed by RCBC as market for KRS news.

(6) Disposal of Residual: In municipally owned landfill site

SUMMARY COMMENT:

The Kelowna Recycling Society operation is considered by some federal (Department of Energy, Mines and Resources) officials to be one of two significant source separation programs in Canada (the other being in Ontario, in East York, a Borough of Metropolitan Toronto).

While the KRS operation is beset by management problems and inefficiencies, it is notable for its comprehensive approach to waste management by handling both residential and commercial waste, by expanding from depot to residential curbside collection, by developing a relationship with local civic authorities over time, by linking with a wider network of at-source program operators, and by handling both fibres and glass.

The evolution of KRS from a garage depot to its present processing facility suggests an increasing impact on local waste collection and disposal. Recovery in 1976 amounted to 327 tons, climbing to 675 tons in 1977, and reached 1,058 tons in 1978. Yet with an operating budget in 1978 of \$104,480 (does not include capital amortization or rent), and therefore with

an extrapolated cost of \$99/ton to deliver its product, KRS is clearly "breaking even" by virtue of various subsidies (labour grants, free rent, disposal credits, provincial matching funds). It is also apparent, though perhaps not from this description, that KRS has survived in the face of odds, because of the zeal of a single family, aided by local and provincial environmental groups.

For specific innovations, the KRS example is instructive as a program which:

- receives a diverted disposal credit
- markets through a network (RCBC with 17 member groups)
- hauls to market jointly with a neighbouring program
- exploits commercial sources of recyclables
- provides special set-out containers in its curbside pilot area
- has a relatively large equipment pool
- is considering closer integration with municipal refuse operations

Contact Person: Marianne Viita (604) 763-0778
Kelowna Recycling Depot
415 Haynes Avenue
Kelowna, British Columbia

Reference:

Enertask Consultants. Community Based Recycling in British Columbia. Ottawa, 1979. (Prepared for Conservation & Renewable Energy Branch, Department of Energy, Mines and Resources)

Note: After this appendix was completed, it was learned that the RCBC/Enertask Consultants report on the KRS curbside pilot program was no longer in preparation due to misplacement of data records.

APPENDIX 3

Place: Marblehead, Massachusetts

Population: 23,000

Residential Waste Generation:

Approximately 8,000 tons per year in 1977/1978;
average of 729.2 tons per month.

SES: Affluent suburban community within Boston
Metropolitan Area. Median income of \$12,600
per year (1976); median education level of
13.2 years.

Refuse Collection System:

Prior to May 1977, four packer trucks employed
for twice per week residential refuse
collection carried out by municipal crews.
In May 1977, refuse collection service cut
back to once per week, and the packer fleet
reduced to three. Cutback was made possible
partly because of reduced refuse quantities
diverted through source separation.

Separate Collection System:

Between 1972 and 1977, there was a once per
month curbside collection of each of four
materials, i.e., one week paper was collected,
the next week cans, the third week clear glass,
and the fourth week brown glass. An unstaffed
drop-off point was also maintained at the
former town landfill site. Beginning in
January 1976, drop-off point retained, but
curbside collection changed to weekly multi-
material single-pass system in which all
materials collected simultaneously in same
compartmentalized truck. The new program,
"Recycle Plus" is the focus of this appendix;
no further reference is made to the original
program and little reference is made to
operational aspects of the drop-off program.

Administrative Mode:

Municipal Board of Health Director administers
operations. Test period from January 1976 to
June 1978 involved administration of federal
grant by EPA staff; program planning, monitoring,
analysis and documentation by a consulting
company; and operation of public awareness
program by subcontractors to the principal
consultant.

Method Description:

1. Start-up Animation Process

Date Started: January 1976

Date Ended: Still operating, but without federal subsidy for equipment and consulting services.

Motivational Impetus: Federal EPA interest in testing feasibility of multi-material recovery through single-pass compartmentalized collection vehicle. Town, concerned about forced closure of incinerator (August 1975) and regional transfer/disposal cost of \$18.95 (U.S., 1976) per ton, agreed to co-operate.

Publicity: Intensive community awareness program carried out between July 1975 and May 1976. Components included newspaper, TV and radio coverage; development and widespread employment of logotype; distribution of a community letter; design and erection of posters; intensive school campaign including teacher workshops, curriculum development, and flyers sent home with students; presentations at meetings and submissions to bulletins of community groups; motivational theme focused on cost savings. Over the nine-month period, promotional agent spent 540 person-hours and incurred \$850 in material cost.

Since summer of 1976, there has been little ongoing promotion because administrators feel that "everyone is educated." Source separation is mandatory but this by-law has never been enforced.

Funding Sources: Federal EPA demonstration grant (\$80,000).

2. Collection:

Householder Preparation Requirements:

All aspects of "Recycle Plus" geared to maximizing participation by elimination of previous infrequent collection intervals, confusing collection schedule, different-day collection of refuse and recyclables, and strict preparation requirements. Regarding latter, householders are asked to prepare materials in following manner:

Paper: All flat paper acceptable, i.e., newspapers, magazines, junk mail, phone directories, envelopes, paper bags, etc. Paper may be set out tied or in paper bag.

Glass: Clear glass must be segregated from brown, green and other tinted glass. Neither washing nor metal/plastic/paper contaminant removal is necessary. Glass may be set out in a sturdy cardboard box, an old waste basket or any other durable container which is left behind by collectors for reuse.

Metal: Metal cans and aluminum, i.e., trays, foil, are acceptable. Neither washing, nor flattening, nor label removal, nor "tin" - aluminum separation is necessary. Metal may be placed in either or both glass set-out container(s); that is, glass and metal are co-mingled during storage, set-out, and collection.

Other Requirements: Suggestion to label glass-metal set-out containers for easier identification by collectors (when refuse and vegetables were collected on same day). Plastic bags proscribed for any material set-outs, paper bags proscribed for glass-metal set-outs. Warning that improper sorting and/or improper packaging will result in non-collection.

Note: After one year of program operation, consultants recommended:

- 1) washing of cans/glass to reduce odour and attractiveness of set-outs to animals;
- 2) tying of bagged paper in bad weather to eliminate litter. Consultants point out minor collection problem in winter when paper and plastic containers freeze to ground; also, that paper bags as glass-metal set-out containers may be preferable to rigid containers because bags can be thrown into paper compartment on truck rather than being returned to curbside.

Equipment and Manning:

- Two compartmentalized trucks, each with 18.8 cu. yd. capacity and partitioned into three sections for paper/clear glass-metal/coloured glass-metal, loaded by (partitioned) hydraulically operated buckets at rear of truck. (See section 7 for Rendispose prototype details, modifications and recommendations).

- Two three-person crews (one driver and two collectors per crew) employed because of sensitive labour situation, but two-person crews considered preferable. (Smaller crews could complete collection in available hours and would reduce labour cost.)
- Over an eleven-month data collection period (January to November 1976) each crew collected an average of 4.1 tons per day during 3.1 hours per day of collection. Compartmentalized truck crew productivity was calculated to be 1.3 tons per collection hour per crew. (Collection productivity for two-person crews was found to be almost as high as for three-person crews.)

Method: Collectors dismount riding position (on bucket loader), collect materials from both curbsides and deposit materials into appropriate section of loading buckets. Bucket hydraulics controlled by collectors who visually determine bucket unloading position and angle. Loading time averages 30 seconds per bucket dumped and truck holds 15 - 30 buckets per load. Collectors return empty rigid glass-metal set-out containers to curbside and remount riding position. Full truck travels to off-load site where materials ejected by hydraulic tipping body; three material compartments emptied separately.

Volumes: Average monthly tonnages for 1977 were 76.6 tons of paper and 71.0 tons of glass/cans through curbside collection, and 20.4 tons paper and 12.4 tons glass/cans through drop-off collection for total of 97.0 tons paper and 83.4 tons glass/cans per month. This combined paper/glass/cans total of 180.4 per month amounted to 25% of total residential waste (15.7 pounds per capita per month).

Schedule:

- Weekly collection frequency chosen and maintained to maximize participation, despite fact that weekly service increases program cost. (Cost increase results from need to service more homes per week, small quantity of materials per stop per week--13 pounds per home, and non-participation of some residents.) Consultants point out that fortnightly collection might be more cost effective, but that participation would decline somewhat due to longer storage interval, confusion over collection schedule, and inconvenience.

- Same day collection of refuse and recyclables originally chosen to make recycling collection day more convenient and easily remembered for householders. Over test period, the major problem with this parameter was the difficulty experienced by monitors and collectors in distinguishing recyclable set-outs from refuse. It was also suspected that recyclables set out with refuse lacked the visibility to induce non-participants to source separate.

When refuse collection was cut back (May 1977) to one day per week, the recyclables collection was moved to the former refuse collection day; therefore, the system was changed to different day collection of refuse and recyclables, and is recommended by consultants for reasons of more efficient collection and ability of visible set-outs to advertise program.

Haul Distance: Slightly over 600 homes serviced per day per truck but number of routes and route miles not specified. Forty-five minute off-route travel time to materials buyer in Salem, Massachusetts; round-trip made once or twice per day depending on routes which vary in quantities collected.

Seasonal Variations: None noted in text of consulting report, but 1977 data tables indicate both higher recyclables recovery and refuse generation in May/June compared to other months; likely due to spring cleaning, interruption of collection schedules due to winter storms and summer-time absenteeism.

Costs: (Collection only, no administration or promotion costs allocated.)

- September 1976 purchase price of approximately \$21,000 per collection vehicle, estimated to give seven years of service.
- Labour cost of \$262 (U.S., 1976) per collection day for two three-person crews (wages, fringe benefits and associated direct costs on full cost basis).
- Collection vehicle cost of \$42 (U.S., 1976) per collection day for two compartmentalized trucks (depreciation, maintenance and fuel costs, on full cost basis).

- Drop-off collection bin rental cost of \$195. (U.S., 1976) for three bins and bin hauling cost of \$55 per haul to Salem.

Above costs allocated on full cost basis, but actual costs are less because three men transferred from refuse to recycling collection and no additional men employed. In 1976, full cost averaged \$6,696.83 (U.S.) per month and actual cost averaged \$3,989.83 (U.S.) per month.

For 1977, full and actual costs averaged \$7,532.00 and \$4,185.20 per month respectively. (Wages rose, but one refuse packer eliminated and daily packer cost saving of \$131 per packer credited to actual cost of source separation.) As 180.4 tons of material collected per month in 1977, actual cost amounted to \$23.20 per ton. When revenues and disposal credits are calculated for Marblehead's program, net savings on an actual cost basis amounted to \$1,231.40 per month or \$7.37 per ton recovered in 1977.

Participation: Weekly participation rate of 60-65% (estimated from samples monitored on three days in 1976), up from 20% under original program, also mandatory. Results from a 1976 attitudinal survey showed a 90% claimed cumulative participation rate. By material set out and set-out type, 1976 monitorings showed a 30% cans/glass-only set-out rate, a 21% paper-only set-out rate and a 49% cans/glass/paper set-out rate (percentages based on number of participating homes counted). High combined material set-out rate (49%) thought to be a function of program duration.

3. Processing: (Site, Equipment, Method, Manhours, Cost, Product Quality Description)

No in-program processing is carried out. Curbside collection vehicles deliver materials directly from route to "intermediate processor," Matcon Inc. (formerly called Recor, Inc.) and to adjacent paperstock dealer in Salem, Massachusetts. Drop-off collection bin is bulk-lifted to same buyer sites. Marblehead does not require a process/handling site or equipment and does not incur process costs.

The Matcon site and operation is described in Section 10. At the Matcon warehouse co-mingled glass/cans, off-loaded onto the ground from the Marblehead vehicles, are placed into a hopper by a front-end loader. Materials travel along a conveyor line for hand-picking of aluminum and large contaminants, and for mechanical separation (magnetic) of ferrous metal from glass, removal of small glass contaminants (vibrating screen filters, caps and neck rings), and glass crushing. Metal cans are flattened under the wheels of the front-end loader. Written documentation (1976) of the Matcon operation does not reflect reality (1978). Personal contact with the operations manager indicates substantial technical and financial problems. The site is run-down, processing is carried out two to three days per week by two full-time and several other part-time workers, and cost per ton averages \$30 (U.S., 1978). While material quality is apparently suitable for buyers of clear glass and metal, Matcon's coloured glass was unmarketable in 1978, not for reasons of low product quality but because of low demand.

4. Transportation: (Mode, Equipment, Distance to Market, Cost per Ton, Man-hours)

- A. For Marblehead: As noted previously, materials hauled to Matcon by collection vehicles and by commercial bulk lift of drop-off bin. Trip is a five-mile distance which requires about 20 minutes of travel time and a total trip time of 45 minutes for curbside collection vehicles. Man-hours for commercial bulk lift of drop-off bins are not incurred by Marblehead, but the 1977 lift charges averaged \$350 per month. (As lift fees include allocations for commercial and residential corrugated cardboard hauling, cost per ton for 32.8 tons per month residential cans/glass/paper cannot be deduced from available printed data.) Man-hours for transportation of curbside vehicles to buyer site averaged 1.5 hours per day per crew in 1977 (total of nine man-hours per day for two crews of three persons each). As 1977 total daily collection cost (vehicle and labour) was \$304 per day and as haul to market consumed 29% of working day, haul cost may be roughly deduced as \$88 per day or \$21.46 per ton on a full cost basis.

- B. For Matcon: Materials hauled by truck and rail to various markets in New England and as distant as Indiana and New Jersey. No man-hours incurred for in-house transportation because all shipping done by commercial haulers at rates which amount to \$18 to \$24 (U.S., 1978) per ton.
5. Marketing: (Price, Buyer, End-use, Contract Terms, Alternative Markets)
- A. For Marblehead: Under contract to Recor/Matcon since 1975 and under contract to a paperstock dealer since Recor stopped buyer paper, Marblehead was selling glass, cans and paper for \$10, \$10 and \$8 per ton respectively in 1978 (floor prices as specified in current contracts). Price fluctuations have affected the program economics of the Marblehead program. For example, while material quantities increased slightly from 1976 to 1977 (from 2,121 up to 2,168 tons per year), revenues dropped by \$10,000 (from \$35,595 down to \$25,540) per year. Under contract, Recor can refuse or pay less revenue for heavily contaminated loads. While Marblehead is assumed to have alternative paper markets, the collection of co-mingled cans/glass limits choice of markets for these materials. Two other "intermediate processors" exist in New England, but neither is in close proximity to Marblehead. The glass container manufacturer in Dayville, Connecticut does not consistently buy unprocessed (kiln-ready) post-consumer waste glass and the nearest de-tinning plant for ferrous metal is located in New Jersey; consequently, changing buyers would involve large-scale changes in the Marblehead system, i.e., in-program processing (sorting and up-grading) or revised householder material preparation requirements with appropriate collection vehicle design changes.
- B. For Matcon: Information limited. Matcon estimated to be receiving \$30 to \$35 (U.S., 1978) or less per ton for colour separated glass, \$20 per ton for ferrous metal and close to \$500 per ton for aluminum. Buyers are two glass container manufacturers, a de-tinning industry and various aluminum smelters. Since acquisition, processing and hauling costs are estimated to be in the \$60 per ton range, it appears that Matcon is not covering costs with revenues. Information about contracts with buyers not specified. Matcon vigorously explores alternative markets but has marketing problems especially with glass. For example, Matcon cannot currently sell green glass and revenues for brown glass are low due to the flooding of the amber market as a result of returnable beverage container legislation in the State of Maine. (Non-refillable beer bottles are

returnable in Maine and in 1978 were filling the demand for amber glass at the Glass Container Corporation's Dayville, Connecticut plant, according to Matcon.) The Matcon operation was started in 1974, when tin cans were commanding a revenue of \$100 per ton, five times the revenue of \$20 per ton received by Matcon in 1978. End uses not specified, but assumed to be glass containers, steel and aluminum metal products, and a variety of paper products manufactured by final buyers of paper via the paperstock dealer.

6. Disposal of Residual: According to most recent information (for 1978), the Board of Health Director estimates annual refuse generation at 8,000 tons of which 2,000 tons or 25% is diverted through source separation. The 6,000-ton residual is transferred to land disposal at a disposal cost of \$18.95 per ton (increasing to \$19.05 per ton in 1979). As the transfer-landfill function is performed by a private company on a per ton fee basis, diverted disposal results in direct savings to Marblehead, i.e., 2,000 tons diverted x \$18.95 per ton = \$37,900 saved, and attributable to source separation in 1977. Disposal cost saving is a powerful incentive to continue the source separation program even when revenues are low and collection costs are relatively high. It is the diverted disposal credit, coupled with revenue, which makes the Marblehead program so economically attractive on an actual cost basis.

Summary Comment: The Marblehead program is considered to be the most significant source separation program in the United States, although more recent programs on the U.S. west coast are emerging as significant. The success of the Marblehead program can be attributable to several key factors:

- The existence of an intermediate processor which upgrades and markets recovered materials, and eliminates the need for in-program processing.
- The employment of (and capital subsidy for) compartmentalized vehicles which allow simultaneous collection of several recyclable materials.
- High socio-economic status which is thought to be the cause, along with program duration, of high participation.

- Heavy refuse disposal costs which can be directly credited to source separation when tonnages are diverted.

The Marblehead test program has made two notable contributions to the state of the art, by providing for the design, testing and evaluation of an efficient collection vehicle, and by financing excellent documentation of program operation and economics.

Contact Persons:

- Ray Reed, Director of Public Health, Abbot Hall, Marblehead, Massachusetts, (617) 631-0212
- Bob Clement, Plant Manager, Matcon Inc., 53 Jefferson Ave., Salem, Massachusetts, (617) 631-2083

(Mr. Reed appears to be willing to deal with enquiries even though subsidy period has ended and information requests are a burden due to quantity; Mr. Clement, as a business person, is less available, unless inquirers are interested in purchasing Matcon's expertise.)

References:

Resource Planning Associates, Inc. and the Environmental Protection Agency reports listed in bibliography. (Readers may also be interested in the final RPA report on Waste Composition Analysis for Marblehead and Somerville. Only the first interim report was employed and referred in this Waste Management Advisory Board research.)

APPENDIX 4

Location: Nottingham, New Hampshire.

Population: 1,200 year-round residents (1976 data), but population doubles in summer; mid-1978 data indicates population of 2,000.

Waste Generation: Not specified. Estimated at 263 tons in 1976 (extrapolated). Includes residential, institutional and commercial refuse.

Refuse Collection System: All refuse and recyclables delivered to "recycling plant" by residents and private refuse collector. No municipal refuse collection vehicle service. Refuse and recyclables collection integrated into one waste management system.

Separate Collection System: As above, collection by drop-off.

Administrative Mode: Town, governed by a "Board of Selectmen," established "Solid Waste Disposal Committee" in March 1972 in order to study alternatives to old dump. A member of this committee serves as plant administrator on a voluntary basis. While early marketing was performed by a non-profit environmental organization (Recycling & Conservation Inc. of Kittery, Maine-R&C), town assumed marketing responsibility in June 1977.

Method Description:

(1) Startup Animation Process:

Date Started: January, 1974.

Date Ended: Still Operating.

Motivational Impetus: Small town dumps scheduled for closing in July, 1975 under federal law. Town Board of Selectmen established a Solid Waste Disposal Committee in March 1972 in order to study disposal alternatives. Local sanitary landfill was not environmentally possible and regional landfill was not financially attractive; therefore, recovery of recyclables/incineration of residue was investigated. Study led to contact with State University Cooperative Extension Service's Environmental Specialist, R&C's president and incinerator manufacturer's agent--all of whom helped Committee to draw up proposal for "recycling"/incineration system. Proposal and request for funding submitted to EPA in late 1972 but funding turned down. Second proposal drawn up for joint funding by R&C and town. Proposal explained in

pamphlet mailed to all households and promoted by a newly formed "Volunteers for Recycling" group. At town meeting in April 1973, citizens voted to appropriate town funds, to accept grant from R&C, and to pass a mandatory source separation ordinance.

Publicity: In addition to promotion prior to the town vote, publicity continued through 1976 as follows:

- August 1973--mailing announced groundbreaking;
- September 1973--mailing announced October meeting at which separation procedures explained and special storage containers provided (by R&C) to householders that wanted them;
- November 1973--house-to-house canvass by Volunteers for Recycling with container samples in order to determine number and types of containers desired;
- December 1973--mailing announced January start-up date and plant open house;
- March 1974)
June 1974) mailings reported progress
May 1975) and phone numbers for
August 1976) enquiries.

Note: Neither broadcast and press media, nor school campaigns were used as promotional strategies because of size and geography of community. Mail, meetings and community groups were appropriate strategies.

Funding Sources: As above, capital funding by town and R&C, and special containers by R&C. Operating labour and transport of materials to market, by town. Discount on original incinerator because manufacturer realized publicity value. Grant from State of New Hampshire.

(2) Collection:

Householder Preparation Requirements: All residents (and other waste generators) required by law to separate into four categories: newspaper, cans and other light metal items, glass, and "all other." Glass must be free of metal caps and neck rings. Customers of the private refuse collector must comply with source separation ordinance because collector must deliver refuse in separated form. Ten dollar fine for mixed waste deliveries never enforced. While separation requirements aid material recovery, their main purpose is to improve the technical and financial efficiency of the refuse incinerator from which non-combustible materials should be

diverted. Refuse sample data from 1976/1977 indicated a 95% mandatory separation compliance rate for all materials combined; however refuse samples contained (by weight) an average of 3% glass, 15% newspaper, and 7% cans, for compliance rates of 97%, 95%, and 93% respectively. (See Section 14 for details about the special storage container which was provided to residents and has three compartments for glass, cans and refuse.)

Equipment and Manning: Collection activity consists of receiving delivered materials. Delivered by residents, newspapers and cans/glass are placed on two wooden tables located inside two windows in the recyclables receiving room, and refuse is placed into several plastic carts located in the incinerator receiving room. The private hauler's (packer truck) refuse loads are ejected onto the floor of the latter section, and his 45-gallon drums, which contain recyclables, are off-loaded at the loading dock normally used for outgoing materials.

Collection equipment consists of two tables and several carts. There is no manning of this collection activity per se, although attendants are on hand performing processing activities. Collection (delivery) takes place only during specified hours of operation. Two part-time paid workers staff the plant, but there is no separate person-hour allocation for collection.

Method: As above, residents place materials through two windows onto two tables and place refuse into carts, while packer drums are off-loaded onto loading dock and refuse is ejected onto floor.

Volumes: Following quantities collected in 1976: 70.9 tons glass, 15.9 tons cans, 14.8 tons newspaper, 4.9 tons scrap metal, 0.6 ton aluminum, and 155.9 tons refuse. (Scrap metal not included in separation ordinance because large appliances, etc. were always kept separate from normal refuse.) As waste stream totals 263 tons, the 107.1 tons recovered forms 40.7% of waste stream. The 178.5 per capita recyclables recovery level (based on 1,200 permanent residents) appears low, likely due to a high rate of domestic disposal.

Schedules: Deliveries restricted to two days per week (Saturday and Sunday) year round, and part of Thursday in summer weeks when population doubles.

Haul Distance: No information specified about distance travelled by residents or route miles of private hauler.

Seasonal Variations: None specified, other than need for increased hours of operation in summer due to influx of part-time summer residents.

Costs: None allocated specifically for collection.

Participation: Attitudinal survey carried out in 1974, six months after operations startup. Of randomly sampled year-round residents, 14% had not participated, 9% took household wastes to other local dumps because of their opposition to source separation, and 3% reported increased disposal at home. (Unfortunately, the percent participation cannot be deduced from data, but it can be assumed that participation did not exceed 86%.) Ordinance compliance rates from 1977 research (reported above) indicated a 95% (average) absence of recyclables in refuse delivered by participants.

(3) Processing:

Site: Plant is a 30'x60' wooden structure which houses a small office, a recyclable materials receiving and processing area, a newspaper storage area, and a refuse receiving and holding area. Processed glass and metal are stored in an attached sheltered (but unenclosed) area. The refuse incinerator itself is outside of the building but its feeder hopper is indoors. There is unsheltered, outside storage of rubber tires, large scrap metal items, and incinerator ash. On the opposite side of the access road, there is a small shed (5'x7') for reusable items, free to patrons. The reuse shed has been established to allow safer "dump picking." Wood, brush, and ash are landfilled beyond a treed barrier. Residents are able to scavenge wood from the dump site. Since original construction, the only change made in the plant site was the expansion (from 10' wide to 20' wide) and roofing of an outside concrete slab--the loading dock and storage area for full glass and can bins. These changes allowed more space for maneuvering the forklift and prevented wooden storage bins from freezing to the concrete slab during winter snows.

Equipment:

- For warehousing: used battery-powered forklift (plus battery charger and batteries) with 3,000-pound capacity, carts for refuse storage, wooden bins on castors for unprocessed glass/cans storage, and wooden bins (made from pallets) for processed glass/cans storage and shipping.
- For recyclables processing: glass crusher, can crusher, magnetic separator/conveyor, paper baling frame, and paper baling tools/straps.

- For incineration: pyrolytic incinerator, oil tanks, and ash conveyor. (Original excess air incinerator inefficient because it used too much oil and burned too little refuse per hour, therefore replaced by pyrolytic incinerator in 1975. Second incinerator uses oil only to control stack emissions and to ignite initial charge for each burning period.)

Method:

- Newspaper: Received at window from residents and fork-lifted from packer unloading dock, newspaper is hand baled in a specially designed baling frame. To bale, attendants first place a wooden pallet in the bottom of the steel frame, then place six strands of 3/4" steel strapping across the pallet, hook the straps to steel pipes which form the sides of the frame, and then cover the bottom with a sheet of cardboard. Attendants pile newspaper in the prepared frame in nine stacks, to a 54-inch height which approximates 1,500 pounds--a mill-size bale. Next a sheet of cardboard is placed on top of the stacked paper, and a manual strapping tool is employed to tighten the straps. Finished bales, baled at a rate of one per 7-10 days, are forklifted to the newspaper bale storage area.
- Glass: Received at window from residents and forklifted from packer unloading dock, glass is freed of any metal contaminants left on by householders, and is colour sorted by attendants into three bins. Glass is mechanically crushed in a one-horsepower crusher mounted on a metal track over shipping bins. To crush, attendants forklift full sorting bins to an upper level above the crusher. Glass passes through a hinged opening in the sorting bin, pours through the crusher, and falls into a shipping bin at floor level. Contents of two or three sorting bins (600 pounds each) are crushed per week. Full shipping bins (pallet boxes), weighing 2,300 pounds each on average, are forklifted to the glass storage area.
- Cans and Other Light Metal: Received at window from residents and forklifted from packer unloading dock, cans are emptied onto the conveyor belt of a magnetic separator which drops ferrous (tin, bi-metal, steel) cans into one bin, and more valuable all-aluminum cans and foil into another bin. During magnetic separation, attendants remove wire, aerosol cans and other objects which cannot be put into the can crusher. To crush, attendants dump can bin contents into a hopper-fed can flattener, after which cans fall into shipping bin. Full shipping bins are forklifted to the cans storage area.

Refuse: The incinerator feed hopper, built into the floor of the incinerator receiving area, is filled by attendants. Cart-loads of refuse delivered by residents are tipped into the hopper, and refuse, ejected onto the floor by the packer, is shoveled into the hopper. A hydraulic ram pushes refuse through a hydraulically operated charging door into the pyrolytic (starved oxygen) incinerator. Incinerator ash is manually raked out through a door onto a conveyor, and moves into a holding bay which is emptied of ash periodically by a town front-end loader, brought in to transfer ash to the nearby former dump site.

Man-hours: Hours of site operation amount to 32 person-hours per week in winter and 40 person-hours per week in summer. While program documentation does not specify minimum or optimum operating time, over-staffing is pointed out. Labour safety legislation requires that two workers be on duty during equipment operation, and convenience of residents requires that the plant be open at least two days per week year-round and on a third day during summer. (Average weekly plant throughput is only 5.1 tons per week.)

Cost:

- Capital Costs: (1976 U.S. market prices, fully allocated, exclusive of discounts and grants to Nottingham)
 - a) Site preparation and construction (1973), plus dock extension (1975) and dock roof (1976), cost \$26,000.
 - b) Equipment items listed above for warehousing, processing, and incineration, cost \$47,500.
- Annual Operating Costs: (1976)
 - a) labour - \$5,320
 - b) fuel oil - \$0 (1975 inventory sufficient for 1976)
 - c) electricity - \$493
 - d) all other non-capital - \$1,246

Gross operating cost of \$7,059 in 1976, down from \$9,013 in 1975, and \$14,835 in 1974. Net operating cost of \$4,221 (after revenues credited), down from \$6,406 in 1975, and \$12,728 in 1974. With a 1976 throughput of 263 tons, 1976 gross operating cost was \$26.84 per ton, and net operating cost was \$16.05 per ton. Reduced operating cost mainly due to change to more efficient pyrolytic incinerator which uses less oil than previous incinerator.

(Note that documentation does not show the \$73,500 capital cost amortized. Nottingham incurred no actual debt due to receipt of grants, discounts, and revenue-charging funds for startup.)

Product Quality Description: Apparently suitable to buyers.

- (4) Transportation: (Mode, Equipment, Distance to Market, Manhours and Cost per Ton to Ship)

Recyclable materials shipped by flat bed stake truck, purchased second-hand in 1973 for \$2,800. Weight and volume capacity cannot be confidently deduced from available data but it appears that truck has at least a 9-ton capacity. Although the truck's capital cost is allocated to the plant budget, its operating cost and manpower cost do not explicitly appear in plant allocations; that is, it is not known whether "labour" and "all other" costs listed above under "Annual Operating Costs," include driver wages, fuel, and maintenance for transport of materials to market. Information on manhours, and shipping cost per ton not specified. Market hauls are made to points in New Hampshire, Massachusetts, and Connecticut.

- (5) Marketing:

Price: Between 1974 and 1977 prices have fluctuated. Spring 1977 prices were approximately \$33/ton for newspaper, the material with the widest price fluctuation; \$32/ton for glass, which rose steadily in price; \$8/ton for ferrous cans, a commodity which almost steadily declined in value; \$300/ton for aluminum, for which the price remained constant since 1973; and \$23/ton for scrap metal, which yielded only slightly less in 1974.

Buyer and End Use: Glass sold to a glass container manufacturer in Connecticut; paper usually sold to a paperboard mill in Massachusetts but sometimes to an insulation manufacturer in New Hampshire; ferrous cans sold to an intermediate processor and a scrap dealer, both in Massachusetts for ultimate use as tin/steel after detinning; aluminum sold to an aluminum manufacturer (which operates a depot at a nearby shopping mall) and to a scrap dealer; and scrap iron sold to two scrap dealers for ultimate use as steel. Altogether, four scrap dealers listed as buyers of Nottingham metals). Markets for rubber tires not specified.

Contract Terms: Not specified.

Alternative Markets: 1976 documentation indicated exploration of another glass market, a container manufacturer in Massachusetts. No other mentions of active

marketing. Mixed paper and corrugated were initially accepted and shredded (but not baled) at the town plant, but were dropped due to unstable prices and heavy shipping cost.

- (6) Disposal of Residual: Incineration system described above. Large organic objects landfilled along with incinerator ash. It is notable that alternatives compare unfavourably with the recovery/incineration system which had a net operating cost of \$4,221 in 1976. Estimates (1972) costed local sanitary landfill at \$17,740 annually if a site could be found, and Nottingham's share of regional sanitary landfill at \$15,530 annually if a site had been established. Incineration without recovery of non-combustibles (glass, cans, scrap metal), would have entailed a more expensive incinerator, more incinerator maintenance, a greater landfill burden, and loss of materials revenues, even though capital cost for recovery component (\$15,000 U.S. 1976) would not have been incurred.

Summary Comment:

The Nottingham prototype is itself significant as a comprehensive waste management approach, in which multi-material recovery is integrated with disposal of residual. More significant is the fact that over twenty other communities in New England have advanced the state of the art by adapting the concept to local and regional circumstances.

The Nottingham program is based on maximum material marketability which requires a maximum effort. Consequently, in-program labour and equipment (underutilized) are employed for monitoring contaminants on materials delivered, glass colour separation, ferrous-aluminum can separation, material volume reduction, and transport to market. Among second generation programs, the tendency is toward minimum effort, which sacrifices material marketability. Consequently householder contaminant removal standards are relaxed, attendants perform less processing, and in most cases materials are sold to dealers who pickup and process materials for resale. These dealer arrangements cut in-program costs, but limit market versatility and price received. In simplifying material volume reduction, other towns ship glass in roll-off containers, use "rough handling" techniques for glass, and flatten cans under the wheels of vehicles.

Most significant are the several regional systems based on the Nottingham prototype. Although patrons and commercial haulers must deliver to a more distant and central collection site, advantages include: better utilization of equipment

and labour due to avoidance of excess capacity and duplication at small local plants; economies of scale in processing activities; employment of more efficient bulk loading and container systems which are justifiable with larger throughput; and increased bargaining power from centralized marketing.

Analysts of the Nottingham prototype point out that many considerations are involved in establishing Nottingham-type programs appropriate to local circumstances. New program designers are urged to carefully analyze markets (which will determine all system features), waste stream quantity and composition, equipment and labour requirements, costs, and disposal diversion priorities. The crucial trade-off is effort/cost vs. marketability. Other trade-offs include capital vs. labour intensivity (i.e., mechanical baling may save labour time but underutilize capital, whereas hand baling may be appropriate if labour is surplus and if newspaper is the only fibre handled), and more effective mandatory separation vs. more politically acceptable voluntary participation (either requires rigorous public education).

Contact Persons:

Selectman Elizabeth Kotler, Nottingham, New Hampshire, (603) 679-8064 (information on day-to-day plant operation).

Richard Tichenor, Recycling & Conservation Inc., Box 276, Kittery, Maine, 03904, (207) 439-1755/0279 (written documentation and referrals to second generation programs).

References:

Several publications by Tichenor are listed in the bibliography.

APPENDIX 5

Name of Program: Seattle Pilot Program: SORT (Separate Our Recyclables from Trash) and Variable Rate Can Study- a pair of programs testing the economics of source separate curbside collection, and the impact of monetary disincentives on household waste generation and on participation in source separation.

Location: Seattle, Washington.

Population & Number of Households: Total of 14,508 households on 30 refuse collection beats involved in programs, but only 9,903 households on 20 beats receive source separate pickup service.

Waste Generation: Based on control areas (non-pilot program areas), average of 46.25 lbs. per household per week.

SES: Pilot beats chosen to reflect SES range in Seattle in order to test effect of SES on participation in source separation.

Refuse Collection System: Homeowners pay mandatory \$5.20/month fee to City for once per week backyard refuse collection, carried out by two commercial refuse haulers under seven year contracts to City.

Separate Collection System: Multi-materials, single pass, monthly curbside service employing modified pickup truck plus trailer, for collection from 20 garbage beats.

Administrative Mode: Sponsored by City of Seattle Solid Waste Utility. Source separate operating system responsibilities contracted to private company, Seattle Recycling Inc. (SRI). Consulting company, SCS Engineers Inc., retained by Utility to design system, and to evaluate program progress at six reporting intervals.

Method Description:

(1) Startup Animation Process:

Date Started: April, 1978.

Date Ended: Still operating. Sixteen-month pilot scheduled to end in October, 1979.

Motivational Impetus: Combination of complaints about refuse collection cost, disposal problem, and familiarity with source separation as an alternative.

- Citizen group delegation visited Seattle City Council in 1977. Protested fact that those with little refuse (due to reduction, composting, and use of local buy-back depot centres) had to pay flat rate refuse fee

to City, therefore subsidizing waste producing neighbours.

- City faced critical disposal site shortage.
- Local availability of buy-back centres for paper, glass and cans (operated by SRI).

Subsequent discussions resulted in design of two pilot programs involving three research groups:

- 1) "Variable Can Rate Study" (VR) participants pay for refuse collection according to number of garbage cans set out weekly:
 - \$5.20 - 2 to 4 cans
 - \$4.00 - 1 can
 - \$1.00 - no cans (residents who deliver refuse to transfer station are not charged an access fee)
- 2) "SORT" participants receive free curbside collection of recyclables, but are subdivided into two research groups:
 - a) those who pay flat rate of \$5.20 for refuse collection;
 - b) those who pay variable can rate (\$5.20, \$4.00, \$1.00).

Therefore, the three research groups are:

- variable can rate plus source separation (4,777 homes);
- flat can rate plus source separation (5,126 homes);
- variable can rate only, no source separation (4,605 homes).

Publicity: First nine months of public information campaign carried out by a combination of SRI staff, City personnel, two consulting companies and the League of Women Voters (local chapter of a national public interest group).

- SORT publicity activities included: three newsletter/calendar mailings, radio and TV (public service ads and news coverage), newspaper articles (City-wide and local), community meetings, phoning (two phases, first to introduce program and invite participation, second to follow-up on those who said they would participate in SORT but did not do so), bus signs, and displays at fairs. (Special bags, a form of publicity--see below.)
- Variable Rate "publicity" consisted of mailings to homeowners in test areas. Enclosed with explanatory material was a response card which had to be filled in indicating preferred number of refuse cans to be used. City canvassers applied colour coded stickers to 1-can users so that refuse collectors would collect only one can from those homes. Another colour coded sticker was later, but more gradually, applied to 2/3/4-can users by canvassers.

- Full information on publicity costs not available until final report. Promotional costs related to VR study not yet identified. Promotional costs related to SORT, fully allocated to SRI (contractor) and after six months of operation, amount to \$7,533 for administration and consulting subcontracts, but do not appear to include all material expenses.

Funding Sources: Municipal. In 1977, new garbage collection contract price negotiated between City and hauler at \$.25 per household per month less than previous contract, but old householder-paid fee retained, with difference reserved for source separation research.

(2) Collection (SORT):

Householder Preparation Requirements: Householders given two special bags (1-cu. ft. capacity per bag; bags resemble mesh onion bags). One bag for contaminant-free, colour mixed, food and beverage, glass containers, including returnable refillable beer bottles. Other bag for label-free, unflattened, tin and aluminum, food and beverage cans. Contaminant-free newspapers bundled or put into paper grocery bags.

Equipment and Manning:

- Collection vehicle is a 1½-ton GMC flatbed truck. Top and folding sides of truck enclose six bins (2 bins for glass, 2 for metal, and 2 for newspaper). Each bin has two-cubic yard capacity. Upper halves of truck side panels fold downwards over lower halves of side panels for loading materials into bins. Auxiliary 12' trailer, with capacity for another six bins, hitched to truck for routes with heavy participation/recovery, thus increasing collection vehicle capacity to 24 cubic yard/load.
- Collection crew of one driver/collector plus one collector cover 20 pilot area routes per month, at rate of one route per day. (Each route is a refuse beat of approximately 500 homes, but not all homes passed participate in SORT.)
- Collection time and worker productivity improved between first three months and second three months of operation due to better routing, more efficient collection techniques, and change in payment basis (from number of hours worked, to task accomplished). With low participation, disproportionate amount (44%) of on-route time spent traveling between stops.

SORT Collection Performance Summary

Measurement Factor	Average Quantities for Period of Operation	
	Months One to Three	Months Four to Six
Length of Work Day (including travel to route, breaks, and collection time, but excluding lunch)	5.4 hours	4.2 hours
Collection Route Time	4.0 hours	2.9 hours
Stop Time per Household (loading time)	1.12 minutes	.78 minutes
Travel Time between Stops	.88 minutes	.62 minutes
Quantities Collected per Work Day	2.58 tons	2.27 tons
Productivity (tons/hour per 2-man crew)	.64 ton	.78 ton

Method: Crew travels from handling facility to route.

On route, crew picks up bagged/bundled material from curbside and deposits bags/bundles through hinged side panels into bins on truck bed. One or two empty bags are left at curbside for full glass/can bags removed. Bins off-loaded by forklift at handling site.

Recovery: Total of 291 tons of material collected during first six months of program (by weight, approximately 11% metal, 41% glass, and 48% paper). Average household recovery of 48 pounds per month. Monthly household recovery higher in upper (51.2 lbs.), upper-middle (50.8 lbs.), and lower income areas (50.2 lbs.) on average, than in middle (42.8 lbs.) and lower-middle (47.5 lbs.) areas. In variable rate areas, monthly household set-outs smaller on average (47.6 lbs.) than in flat rate areas (49 lbs.); but comparing total quantities collected, recovery in variable rate areas 11% higher than in flat rate areas. (Newspaper and aluminum scavenging, a problem).

Schedules: Collection frequency of once per month, on regular refuse day. City staff recommend source separate collection on non-refuse day to avoid situations where residents set out recyclables along with refuse later in the day and then report missed recycling pickups.

Haul Distance: Route miles not available until final report. Distance from handling site to route is 20 miles. Collection vehicle capacity allows entire route to be finished before off-loading required.

Seasonal Variations: Recovery corresponded with seasonality of refuse generation, i.e., higher in spring. Aluminum component of metal fraction decreased in fall due to less cold beverage consumption in colder months.

Costs: For six-month period:

- \$1,668 - Total capital cost of \$20,038 (equipment acquisition and preparation), amortized straight line over five-year life with 15% salvage value;
 - \$9,261 - Operating cost includes wages at \$4.12/hour for driver, \$3.55/hour for collector; collection bags at \$89/mo. (amortized over 12 months without salvage value); separate allocation for missed pickups; fuel and insurance;
 - \$ 313 - Maintenance includes labour at \$4.40/hr, repair labour and parts;
 - \$2,353 - Administration/overhead includes route planning time and employer-paid employee taxes comparable to Workmen's Compensation, Unemployment Insurance and Canada Pension.
-
- \$13,595 - Total (\$7,035 in first three months, down to \$6,560 in second three months; difference mainly due to lower maintenance, less collection time, and fewer missed pickups).

Collection cost per ton -- \$46.72 (program sponsors emphasize that high cost due to diseconomies inherent in pilot stage, i.e., low throughput, scattered collection areas, etc.).

Participation: First six months:

- average monthly participation rate (% of homes with set-outs) of 21% (range of 19%-24%);
- of all participating homes over six-month period, 47% set out newspaper, 79% set out glass, 72% set out metal (low newspaper set-out rate thought to be due to participation in programs outside of SORT);
- cumulative participation (% of homes participating at least once) of 36%. Only 2.7% added in months four-six, indicating few new converts;
- in variable rate areas, average monthly participation slightly higher (22.4%) than in flat rate areas (20.3%);
- participation directly correlated with income level, from high of 31% average monthly participation in upper income areas, to low of 13% in lower income

areas (27% for upper-middle, 19% for middle, 18% for lower middle) led to consultants' recommendation that upper income areas should be considered for program expansion due to high participation and high recovery;

- set-out monitoring showed that of those who initially said (in phone and door-to-door surveys) they would participate, only 40% actually participated, despite a second round of personal contact and other ongoing publicity.

(3) Processing: (and Warehousing)

Site: SRI Warehouse.

Equipment: Categories and Capital Costs

- metal processing		
	magnetic separator	\$1,879
	conveyor	300
	can crusher	4,500
	equipment preparation	<u>320</u>
	ST	6,999
- glass processing		
	sorting table	50
	glass crusher	1,226
	equipment preparation	<u>908</u>
	ST	2,184
- newspaper handling		
	scale	1,650
- general warehousing		
	fork lift	6,058
	tilt bins (9)	3,820
	rolloff bins (2) (rental)	<u>1,040</u>
	ST	10,918
	TOTAL	<u><u>21,751</u></u>

Method: Collection vehicle bins off-loaded by forklift.

- Metal: Bags of metal cans opened and material fed through magnetic separator for removal of ferrous from aluminum (fed through crusher separately from ferrous). Ferrous cans with labels attached (2% of all cans), discarded as refuse;
- Glass: Bags of glass containers opened and material dumped onto sorting table. Returnable refillable beer bottles hand picked and boxed. No market for colour mixed glass, so glass manually colour sorted into green, brown and flint. Uncrushed brown and green transferred to partitioned (three equal sections) 20 cu. yd. container. Flint, comprising 2/3 of total glass volume, mechanically (formerly manually) crushed to fit into its 1/3 share of roll-off container;
- Newspaper not baled.

Manhours: Two workers allocated to SORT processing, including glass and metal processing, newspaper handling, and storage/preparation for transport/warehousing. Due to procedure modifications and worker familiarity with system, processing time decreased over first three months of operation, but time increased during second three months. Advantage of added mechanical glass crusher, off-set by retraining time for new staff (\$4.00/hour wage results in high staff turnover), and by lower throughput during second period. Over six month period, average of 300 hours per month spent on processing (greater time input than for collection!); amounts to average of 6.1 person-hours per ton: 20.5 hours per ton of metal, 7.1 hours per ton of glass, and 2.9 hours per ton of newspaper.

Costs: Capital amortized as for collection equipment; wages at \$3.30/hour. Total costs include capital, operation, maintenance, and administration/overhead, for six-month period, but do not include costs related to warehouse space which are allocated under overall administration/overhead costs.

- metal processing	\$2,947
- glass processing	2,760
- newspaper handling	1,086
- storage/preparation for transport/warehousing	<u>4,746</u>
Total	<u>\$11,535</u>

Processing/handling cost per ton - \$39.64

Product Quality Description: Apparently satisfactory to buyers.

- (4) Transportation: Details scarce due to fact that SORT materials combined with materials received from SRI buy-back satellite centres, for common shipping:

- newspaper, to local dealer;
- glass, (bulk-lift) three miles to Northwest Glass plant;
- ferrous, five miles to MRI de-tinning plant;
- aluminum, 30 miles to Reynolds Metals plant;
- beer bottles, to two local breweries.

No further information available on mode, equipment, cost per ton to ship, and manhours, until final report.

- (5) Marketing: SORT materials marketed along with other materials collected in SRI buy-back operation, therefore SORT revenues higher than if SORT materials marketed separately.

Prices: For six-month period:

- newspaper prices began at \$36/ton, dropped to \$33, ended at \$31;
- glass cullet price, a steady \$20/ton; beer bottles, a steady \$.60/case;
- ferrous price began at \$60/ton, rose to \$65, ended at \$75;

Total SORT revenue for six-month period - \$11,944.

Buyers: See "Transportation".

End Use: As implied under "Transportation," non-refillable glass containers, aluminum cans, and ferrous cans (after de-tinning), reprocessed (recycled) into glass, aluminum and steel products, respectively; beer bottles refilled. Paper dealer resells to cellulosic insulation manufacturers and to overseas market.

Contract Terms: Contracts not sought for metal and glass materials due to stable prices. Contract for newspaper specifies floor price of \$30/ton.

Alternative Markets: New de-inking plant, Publishers Paper Co. in Portland, Oregon may have effect on paper price, but paperstock dealer intermediary not likely to be bypassed. Markets for metal and glass, stable and strong, requiring little search for alternative markets.

(6) Disposal of Residual: In municipally owned landfill via City transfer station.

- SORT recovered tonnage at pilot stage not intended to be substantial enough to impact on disposal requirements of Seattle.
- Monitoring of separate collection shows participating households diverting 20-25% of waste through SORT (but monitoring cannot quantify waste diverted through non-SORT source separation activities).
- SORT research more interested in impact on refuse collection, but refuse collection not monitored before SORT started, therefore difficulty in measuring SORT impact (difficulty enhanced by poor choice of control areas for monitoring baseline refuse collection data, by idiosyncratic refuse vehicle/crew performance, by different size refuse crews of 2-6 men each, which perform backyard collection).
- Best available data do not indicate a definitive impact of SORT and flat rate or of SORT and VR on refuse collection: on refuse routes with VR only, average household waste set-out for collection (40 lbs/wk) is least when compared to SORT and VR routes (43.3 lbs/wk), and to SORT and flat rate routes (45.8 lbs/wk). Control areas with no pilot program influence have highest average household waste for collection (46.2 lbs/wk). In all three pilot program test areas, refuse collection stop crew productivity is equal--38 houses/crewman/hour, a slightly higher productivity than for control areas--37 houses/crewman/hour. Crewmen operating in control and VR-only areas collect more waste material per hour (.80 ton/crewman/hr), than crewmen in SORT-flat rate and in SORT and VR areas (.76 ton/crewman/hr).

SUMMARY COMMENT:

The significance of the Seattle pilot programs lies in the intent to assess the effect of combining source separation with monetary disincentives. While the pilot programs have been criticized as trying to test too many variables, data at the six-month evaluation stage indicate some interesting results. The combination of source separation plus waste disincentive results in slightly higher participation rates per separate collection, and in slightly higher overall recovered recyclable tonnages, when compared to source separate participation and recovery in collection areas without the waste disincentive; however, the waste disincentive alone have more impact on reducing waste tonnages, than either the combination of source separation plus waste disincentive or source separation alone.

While the SORT program endeavours to test the economics of curbside collection, as a pilot program it lacks the economies of scale to achieve low collection costs. The collection cost in the first six months of operation was \$13,595. Combining collection costs with processing/handling costs (\$11,535) and overall administrative costs (\$11,540), the first six months of the program cost \$36,670 (\$6,112 per month, or \$126 per ton), off-set by a total revenue of only \$11,944.

Due to the availability of excellent data and preliminary evaluation documentation, it is useful to summarize early conclusions and recommendations made by the consulting company retained by the City:

1. Variable Rate Disincentive:

The amount (only \$5.20 for 2-4 cans) and gradation (\$4.00 for 1 can versus \$5.20 for 2-4 cans) of the monetary disincentive are not enough of a penalty to effect either a substantial reduction in waste or a significant increase in source separate participation. Selecting the 1 can rate, were 12% (in VR pilot areas) and 13% (in SORT and VR pilot areas) of households, but a previous refuse study showed that 20% of households used only one can before the implementation of variable rates. It appears that homeowners are willing to pay the difference of \$1.20 for the luxury of being able to put out the occasional second can. A new rate structure should be tested in one SORT and VR pilot area (\$1.00 for no can, \$3.50 for 1 can, \$5.60 for 2 cans, \$7.60 for 3 cans, and \$9.00 for 4 cans). The effect of these rates on decreased waste generation, increased collection productivity, and higher SORT participation, would result in valuable information, for a cost of \$500 (for a six-month test period involving a 500-home route). The lack of incentives for tenants, whose landlords pay refuse rates, is considered to be an insoluble problem.

2. Collection Frequency:

The effect of more frequent collection on costs and revenues should be tested. This could be done by combining

two low participation routes into one, and using the resulting extra day for increasing one test area to a twice per month collection frequency (for a six-month test period involving a 500-home route, for a cost of \$2,000 for publicity, collection, and administration).

3. Public Information:

Phoning is a cheaper and more effective personal contact tool than doorbelling. Mass media are less appropriate than mailing, phoning and doorbelling, when advertizing pilot programs with scattered test areas. Yard signs erected the day before collection have not raised participation.

Low participation in low income areas may be due to lack of information about SORT; therefore, another door-to-door canvass should be carried out, employing known, local neighbours to explain SORT.

4. Survey:

An attitudinal survey should be made of several hundred homes in order to collect useful planning information such as:

- why people are not participating;
- whether people participated in past programs, and whether people are participating in other non-SORT programs (could confirm hypothesis that low newspaper set-out rate is due to patronage of buy-back centres);
- attitude toward collection frequency;
- whether householders would pay for SORT service and how much.

(Survey should be carried out by City personnel rather than by expensive consultants.)

Other noteworthy aspects of the SORT/SRI operation include the ability to effect higher market prices by pooling materials for sale, the use of the task basis for paying collection workers, the recommendation against same-day collection of refuse and recyclables, the provision of special bags for set-outs, the commitment to collect hard data by rigorous monitoring, and the use of computerized data analysis techniques.

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APPENDIX 6

Program Name: "WeatherCheck," a cellulose insulation company employing Native people.

Place: Winnipeg, Manitoba

Households (Served):

360 residential city blocks with an estimated 20,000 single family dwellings; miscellaneous trailer courts, apartment buildings, senior citizen complexes, schools and printing companies.

SES: Middle class, "liberal" areas identified for collection routes.

Regular Collection System:

Residential refuse picked up once per week; details not available from, or relevant to, WeatherCheck.

Separate Collection System:

- Curbside collection of newspaper from single family dwellings.
- Bulk newspaper collection: (1) from storage boxes provided to schools and trailer courts; (2) from printing companies as free garbage pick up; (3) from laundry rooms in apartment and senior citizen complexes.

Administrative Mode:

Coordinated by three administrative staff of this non-profit corporation.

Method Description: Newspaper

(1) Start Up Animation Process

Date started: November, 1977

Date ended: Still operative

Motivational Impetus: Skill training for Natives migrating to city

Publicity:

- "Pretty" Native girls hired for door-to-door canvas (personal request to save newspaper) in residential areas; approaches to superintendents of trailer courts, senior citizen complexes and apartment buildings; followed by leafletting of individual units once management endorsement obtained; approaches to management of printing companies and principals of schools.

- Pitch combines Native development with environmental and energy savings.

- Leaflet designed to look "cheap" in line with sponsoring group's poverty.

- Radio and TV talk shows; news articles in daily paper.
- Costs not identifiable (treated as part of collection cost per ton).

Funding Sources:

- Start up funding from a \$200,000 local Employment Assistance Program (LEAP) grant for developmental and training funds (awarded to sponsoring body, "Project for Native Industrial Training").
- Repayable loan from municipal government for purchase of hammermill equipment used in manufacture of insulation.

(2) Collection

Householder Preparation and Handling Requirements:

- At beginning of curbside program no preparation specified; mixture of loose, bundled, bagged and boxed newspaper created litter problems; participants therefore educated to set out for weekly pickup in plastic garbage bags, necessary to keep material dry.
- Apartment and senior complex dwellers store in unit until night before bulk pickup when they transfer bundled paper to refuse room on each floor.
- School and trailer court residents deposit loose paper into unmanned boxes placed at playgrounds of schools and at entrances and exits of trailer courts; boxes constructed by Native carpenter.

Equipment and Manning (current system)

- 2 step vans (similar to postal vehicles) each with 3-man crews (driver and 2 collectors) used for curbside collection, 5 days per week.
- 1 step van with driver/collector used for bulk locations, 5 days per week.
- total of 3 trucks and 7 collection workers.

Method:

- Curbside: Collectors collect from both sides of block by opening garbage bags, depositing paper into van, and returning bags to mailbox for reuse at each set-out site.
- Schools and trailer courts: Driver /collector enters box and pitches paper into van (no mechanical bulk loading).

- Apartments and senior complexes: Arrangements made with superintendent to use freight elevator on one designated day per week; collector starts on top floor, transferring papers from refuse rooms (placed there the previous evening by tenants) to elevator until all floors emptied; truck loaded on bottom floor. (e.g. one 32-floor building is emptied on Tuesday morning, between 10 and 11 a.m., yielding $1\frac{1}{2}$ -2 tons/wk.).

Tonnage:

12 tons/day needed for cellulose plant; 9 tons collected daily from curbside; 3 tons from bulk collection points.

Schedule:

Weekly curbside pickup with each truck collecting from 18 residential blocks per day (2 trucks X 18 blocks X 5 days = 360 blocks per week) not on same day as refuse pickup but consideration being given to coordination with municipal collection system).

Haul Distance:

Size of collection routes vary; average of 3 miles from collection routes to plant.

Seasonal Variations:

- Demand for insulation drops in spring and rises in summer/fall.
- Collections suspended for 1 spring month and paper warehoused at other low periods of plant operation.
- No variation in participant behavior identified.

Costs:

- Originally, \$136/ton reflecting low throughput, heavy (labour intensive) publicity, "once only" dropoff box construction, and collection crew training.
- Currently \$36/ton:
 - Total of 7 full-time crew members @ \$25/day each.
 - Total of 3 trucks @ \$50/day each: \$25 rental, \$10 gas, \$15 maintenance and insurance (capital purchases not permitted by LEAP).
 - Curbside truck/crew productivity is $4\frac{1}{2}$ tons/day, at a cost of \$125 per day, for a cost per ton of \$28; publicity, administration and overhead add another \$8/ton for a total collection cost of \$36/ton.

Participation:

Estimated 90% participation from daily news subscribers in collection area attributable to concern of "liberals" for native and ecology issues.

(3) Processing:

Site: "Small" site in city core rented for \$45,000/yr. (also houses insulation manufacture operation).

Equipment: Conveyor

Method: Newspaper manually off-loaded from step vans onto conveyor from which glossy papers and boxes manually pulled.

Manhours: 2 full-time sorters

Cost: 2 sorters paid \$25.00/day each; conveyor and site costs not allocated to sorting; as 12 tons/day sorted (upgraded), incremental labour processing costs are \$4.17/ton.

Product Quality Description: Suitable for their own cellulose insulation manufacture.

- (4) Marketing: Object of collection program to acquire materials for WeatherCheck's own cellulose insulation manufacture. (transportation, buyer, contract terms, alternative markets - not applicable). After sorting, material fed into hammermill grinder, mixed with fire retardancy chemicals, and blown into bags; 6 full-time mill workers @ \$25/day include staff who performed initial door-to-door publicity canvas.

Cost/Revenue:

- Total annual operating cost estimated to be \$350,000 including labour, (18 persons total) and equipment for collection and manufacture, publicity, administration, capital loan payments, and site rental.
- Annual gross revenue projected at \$600,000; results from 800 bags of insulation per day X \$4.00 per bag revenue = daily sales of \$3,200 X 200 working days (does not total to \$600,000).
- Profit of \$600,000 less cost of \$350,000 = \$250,000, minus another 25% (\$62,500) loss from downtime, results in net profit of \$187,500.
- Program "broke even" after 6 months of operation.

- (5) Disposal Of Residual: No information available from WeatherCheck about effect of program on normal refuse collection system.

Summary Comment:

The Native cause is a key participation stimulant. Labour costs are minimal due to low wages. The program is purposely labour intensive and there is no emphasis on specialized collection or processing equipment until the manufacturing stage.

The curbside collection system has been carefully phased in, beginning with an 18 block area serviced by 2 trucks. Collectors initially knocked on every door in order to train participants. This first collection area required one full day. Within several weeks, collection time was reduced to $\frac{1}{2}$ day for 18 blocks. Then another route, $\frac{1}{2}$ the size of the original, was set up for the second slack half of the collection day. Once people were "trained", the new route of 9 blocks could be covered in $\frac{1}{4}$ day. Next, another 9 blocks were added. Some overtime was required at this third level of expansion until the newest 9 blocks could be serviced in $\frac{1}{4}$ day. Routes were thus established at 36 blocks for daily servicing by 2 truck crews. Further expansion was unnecessary because "raw material" capacity was reached.

The administrator of the program puts heavy emphasis on businesslike management and points out that demand for insulation exceeds supply. There are two other manufacturers of the product in Winnipeg.

Contact Person: Don Marks, (204) 589-2755

Reference: Publicity and other descriptive materials available from Mr. Marks.

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Community Environmental Council, Inc., Christine Olsen, ed. Recycling: The State of the Art. Santa Barbara, California, 1978. Educational handbook based on the proceedings of the California Resource Recovery Association's Second California Recycling Conference, held in Santa Barbara, November 1976. Speaker presentations are edited and grouped into the following categories: successful recycling centre models, national models for source separation, high-technology vs. low-technology resource recovery approaches, markets, public policy, media and education. Booklet includes conference workshop summaries, the CRRA's recommendations to the State Solid Waste Management Board and a list of participants. (133 pp.)

County of Sacramento. Department of Public Works. "Source Separation Program and Draft Pilot Program Proposal." Sacramento, California, 1977. Report, heavily illustrated with figures, outlines a proposed curbside collection pilot project for Sacramento County, California. The design would test the impacts of set-out requirements on participation rates and program costs. Formulas are used to calculate quantities of recoverable materials, costs, staff time, household participation and equipment needs. (25 pp.)

Cunningham, R.T. and Vogler, J. "The Oxfam Wastesaver Project." Solid Wastes (June, 1976), 272-279. Article outlines a source separation program sponsored by Oxfam in order to raise funds for overseas charities. At conceptual stage, authors criticize mechanical recovery and extol virtues of low-technology alternatives. Unique "dumpy" container is described along with other system components: fractions, work force, collection, processing, marketing and equipment. Problems and proposals for streamlining are indicated at each stage. (8 pp.)

Donahue, Bernard A., et. al., Construction Engineering Research Laboratory. Recommendations for Developing the Optimum Method for DA Installations to Comply with 40 CFR 246 - Source Separation for Materials Recovery Guidelines. Washington, D.C., May, 1977. Report lays out implementation techniques for U.S. Department of Army installations, in order that bases can most efficiently comply with federal guidelines. Report sections explain the new law and outline detailed procedures for system design based on existing state of the art research. Concludes with appendices on the law, sample contractual arrangements and further references. (240 pp.)

Garden State Paper Company, Inc. Planning a Separate Used Newspaper Collection System for Your Community. Garfield, New Jersey, 1973. Implementation guide prepared by waste newspaper consuming industry. Covers marketing, gaining local executive and public support, collection techniques, start-up date, sample laws, and cost factors, with a description of contractual arrangements between suppliers and buyers. (12 pp.)

Hansen, Penelope. U.S. Environmental Protection Agency. Residential Paper Recovery: A Municipal Implementation Guide. Washington, D.C., 1975. Brochure for municipal officials. Outlines recommended steps for curbside newspaper collections. Discussing the relative benefits of separate vs. rack collections, the report deals with costs, public vs. private collections, and success factors such as marketing, public education, anti-scavenging ordinances and mandatory vs. voluntary programs. Heavily illustrated with tables and graphs, the manual concludes with sample contracts and specifications for marketing paper. (26 pp.)

Heron, Nye. "Can Communities Afford Collection Centres for Recycling." Solid Wastes Management/Resource Recovery Journal, (March, 1976) 42, 50, 52, 54. Based on a study done by SCS Engineers, Inc. of thirteen collection centres, article assesses the technical and economic feasibility of reclamation centres (public, private and volunteer). Household waste generation, preparation time for recyclables, collection centre processing, labour costs, savings from waste diversion and revenue, are the topics covered and are illustrated with case history data. (4 pp.)

Heron, Nye. "How Successful Are Separate Collection Systems for Recyclable Wastes." Solid Wastes Management/Resource Recovery Journal, (April, 1976), 40, 56, 58-60. Based on twenty-two case histories assembled by SCS Engineers, Inc., article examines the feasibility of separate collection of household recyclables by both public and private agencies. With emphasis on newspaper collection, the effects of public education, scavenger problems and material preparation are set out. The

separate truck approach is contrasted with the rack approach on the basis of: initial costs, equipment and manpower utilization, participation, program performance and economics. (5 pp.)

Humphrey, Cliff. Environmental Action Education Institute. "Sorting It Out in Modesto." Modesto, California, February, 1977.

Article describes a source separate reclamation program run by a west coast environmental group. Includes sections on curbside pickup, materials handling, markets, finances, staffing, philosophic overview and history. Contains tables on budget, volume reclaimed, and income. (8 pp.)

Johnson, Dr. Charles. "Source Separation - A Challenge for the Private Waste Collector." NSWMA Reports, Vol. 13, No. 3 (1978), 1.

Addressed to private enterprise, the constituency of the National Solid Waste Management Association, article treats source separation as an alternative to mechanical recovery. Two successful California separate collection programs are contrasted with two east coast projects. Private contractors are urged to seize the opportunities of curbside separate collection. Article includes an analysis of government jurisdictional responsibilities and points to the trend of increased private enterprise involvement in waste management. (1 p.)

Massachusetts Bureau of Solid Waste Management, Department of Environmental Management. "Preliminary Report on Recycling in Massachusetts Cities and Towns." Boston, Massachusetts, 1977.

Data sheets resulting from a survey list 129 Massachusetts communities with recycling programs, specifying which collect paper, cans and glass. Listed also are dealers, contact persons for programs, and community population figures. Summary data given for ordinances, composting schemes, wood reclamation programs, tonnages, revenues for four fractions, and capital investments. Detailed monthly program management costs set out for the two communities of Newton and Andover. (32 pp.)

Mattice, W.T. National Recovery Systems, Inc. Riverview Glass Collection System. Moncton, New Brunswick, January, 1976.

Report, prepared for EPS-Atlantic Region, summarizes the planning, design, implementation and modification of a curbside glass collection program using sheltered workshop labour in eastern Canada. (28 pp.)

National Center for Resource Recovery. Residential Paper Recovery: A Community Action Program. Washington, D.C., undated.

Assuming that market studies have been done and that a local decision has been made to implement a curbside

newspaper collection system, booklet shows how to gain community support for and participation in the collection. How to marshall community merchant, media, government, service club, and school resources is heavily emphasized in a concrete step-by-step approach. Concludes with a list of questions and answers in order to prime a community action group. (20 pp.)

Ontario Chapter American Public Works Association. A Report on Refuse Collection and Storage with Emphasis on Multiple Family Dwellings. No location listed, April, 1977. Based on a survey of twenty-one responding Canadian municipalities, report draws conclusions about technical procedures of waste management for several housing types. No consideration is given to source separate collections but trends cited in this study may be inferentially useful for reclamation planning. (50 pp.)

Peter Barnard Associates. "Source Separation Study." Toronto, Ontario, October, 1977 and Peter Barnard Associates, McKim Advertizing and Rushton/Shanahan Associates. "Resource Recovery Program: Four Studies in Source Separation - A Communications Approach - Program Review." Toronto, Ontario, undated.

The first brief report summarizes back-up research done for a set of Ontario source separation pilot programs. Information about other programs is combined with "focus group" results, leading to a proposed communications strategy. (19 pp.)

The second report, a slightly expanded version of the first, presents somewhat more definite recommendations. (30 pp.)

Pilsworth, Diana. Kanata Pollution Probe. Municipal Recycling Practices in March Township. Kanata, Ontario, December, 1973.

Report summarizes the Kanata, Ontario, curbside collection of paper and glass from 1970 to 1973. System, evolution, equipment, processing, costs, markets, problems and publicity are outlined with concluding recommendations for local programs and reclamation efforts in general. (90 pp.)

Regroupement des récupérateurs à la source du Québec. Vers une Société de Conservation: La Récupération à la Source. Quebec, P.Q., 1979.

Compiles three other documents: I. "Experience de la Rochelle (France)" which includes diagrams for a special multi-material collection/processing vehicle; II. "Community Based Recycling in British Columbia," which includes case studies of Kelowna, B.C. and the Recycling Council of B.C., as well as a section on equipment requirements for a multi-material handling facility; III. "Recycling: State of the Art", a report on the proceedings of a U.S. west coast conference on source separation in 1976. (295 pp.)

Resource Planning Associates, Inc. Demonstrating Source Separation in Somerville and Marblehead, Massachusetts: Draft Report (Partial). Washington, D.C., February, 1977.

Report about the source separate collection programs in Somerville and Marblehead, Massachusetts. Reviews the stages of system design including decisions about materials to be collected, truck design, collection staff, materials transport, processing, markets, and program economics. A useful distinction is made between full and actual costing methods. Appendices deal with compartmentalized truck performance, collection route analysis and public participation surveys. (106 pp.)

Resource Planning Associates, Inc. Source Separation: The Community Awareness Program in Somerville and Marblehead, Massachusetts. Washington, D.C., November, 1976.

A detailed account of the public education strategies used in the source separation collection programs in these two locations. Report includes intensive analysis of the use of media, schools, and community groups. Exhibits include sample promotional materials such as mail-outs, stickers, calendars, press releases and logos. Contains useful recommendations for both general and specific components of the awareness-raising program. (81 pp.)

Robillard, Paul, et. al. Conservation and Renewable Energy Branch, Department of Energy, Mines and Resources. The Recycling Kit: A Manual Designed to Assist Recycling Projects Funded Under Canada Works. Ottawa, Ontario, January, 1978.

Part III, entitled, "Approaches to Recycling", contains materials related to source separation. From a mixture of Canadian, U.S. and U.K. sources, sections are contributed from municipal governments, volunteer groups, and private businesses including consulting and processing companies. Includes general implementation strategies, broader overviews of technologies and site-specific accounts. (40 reprints)

Rushton/Shanahan Associates. "Source Separation: Qualitative Study of Response to Proposed Communications Programme and the Possible Provision of Containers." Toronto, Ontario, December, 1977 and "Source Separation: Qualitative Study of Response to Existing and Proposed Recycling Programs." Toronto, Ontario, October, 1977.

Both reports are part of a design package for a set of Ontario source separation pilot programs. Reports summarize "focus group" discussions on advertizing, container provision, willingness to prepare waste items for reclamation, and ideal start-up season. (9 and 22 pp. respectively)

SCS Engineers, Inc. Analysis of Source Separate Collection of Recyclable Solid Waste - Collection Center Studies. Long Beach, California, 1974.

Based on thirteen case studies of volunteer, commercial and municipal collection centres, study analyzes the following program components: labour, land and equipment costs; tonnages collected, sold and diverted from disposal; material generation, preparation, delivery, processing, and hauling to market. Report assesses the technical and economic feasibility of operating reclamation centres and is directed at municipal officials and volunteer groups interested in operating centres. (69 pp.)

SCS Engineers, Inc. Analysis of Source Separate Collection of Recyclable Solid Waste - Separate Collection. Long Branch, California, 1974.

Study of twenty-two case histories examines both rack and separate truck approaches to collecting source separated recyclables, mostly newspaper. Each approach is analyzed for start-up costs, equipment and labour requirements, program performance and economics. Models are used to overcome analytical problems caused by wide disparities in case history data. A model is developed for decision-makers who, by plugging in local data, can determine the economic viability of a curbside source separation program. (152 pp.)

SCS Engineers, Inc. Evaluation of a Compartmentalized Refuse Collection Vehicle for Separate Newspaper Collection. Long Beach, California, May, 1976.

Report summarizes test of a compartmentalized vehicle used in southern California. Compartment was built into the upper front bulkhead of a conventional packer truck. Paper was lifted into the compartment by a hydraulic bucket mechanism. Report includes a model developed to compare cost-effectiveness of collection approaches at different materials revenue and participation levels. (87 pp.)

SCS Engineers, Inc. Evaluation of the San Diego Separate Newspaper Collection Program. Long Beach, California, March, 1976.

Report documents how a cost-effective collection system was designed for a city thinking of discontinuing its source separate newspaper curbside pick-up scheme. (51 pp.)

SCS Engineers, Inc. Final Research Design: Seattle Variable Rate Source Separation Pilot Programs. Long Beach, California, July, 1977.

Study describes a design for a three-part test waste management program in Seattle, Washington. Design proposal will test whether a mandatory limit on waste disposal is an incentive to participation in source separation programs (of two test areas with mandatory garbage limits, one has a curbside collection, the other has a drop-off centre. The third area has a source separate curbside collection but no garbage limit).

Other topics covered are: area selection, information program, monitoring, evaluation, techniques, market survey, scheduling, management, bid specifications for contracts, manpower and budget allocation. Sample public information exhibits are appended. (73 pp.)

SCS Engineers, Inc. Project SORT Draft Report. Long Beach, California, 1978. Report documents the planning stages and first six months of operation of a multi-material curbside collection program operated by a private hauler in San Luis Obispo, California. The report describes valuable techniques for projecting generation, establishing markets, evaluating participation variables, choosing equipment, and costing a program. The methodology is designed to be useful for public and private officials who are looking at the incremental costs and savings of separate curbside collection. (88 pp.)

Seldman, Dr. Neil N. "Who Takes Out the Garbage in D.C.?" Urban Systems Design (October/November, 1975), no page numbers. Article condemns high-technology resource recovery facilities as systems that are predicated on continued high generation of wastes. Decentralized, employment-intensive, source separation systems are lauded by the author, especially Ecocycle, Inc., a private firm in the State of Virginia. (4 pp.)

Seldman, Neil and Drewry, Virginia. "Recycling Garbage: Neighborhood Programs the Answer in D.C.," Washington Post. December 4, 1977, C3. Article comments on conventional disposal and high-technology resource recovery options. Authors outline several examples of recent source separation programs in the U.S. A low income public housing project gets special emphasis. Article includes a section on institutional barriers to low-technology options and concludes with comments in defense of racial group participation. (3 p. reprint)

Skinner, John H. "The Impact of Source Separation and Waste Reduction on the Economics of Resource Recovery Facilities." Paper presented at Fifth National Congress on Waste Management Technology and Resource and Energy Recovery. Dallas, Texas, 1976. Paper sets out the debate over the relative importance and potential conflicts between three waste management options-- waste reduction, source separation and mixed waste recovery. Concludes that all three options are necessary. Takes a closer look at local concerns about the economic impact of waste reduction and source separation on recovery. Uses hypothetical calculations and tables to illustrate the impact of source separated paper and returnable beverage legislation on a recovery

facility. Using incremental costing, author shows that plant processing costs and revenue losses are not significantly affected by implementation of the other options. (19 pp.)

Solid Waste Task Force. The Potential for Newsprint Recycling in Helena. Helena, Montana, January, 1978. A detailed proposal from a Task Force to a Citizens' Council for a rack approach to the separate collection of newspapers. Topics include estimating generation, pinpointing markets, comparing costs of various separate collection truck options, suggesting an educational program, proposing staff arrangements, and scheduling implementation. (28 pp.)

"Source Separation of Paper." NCRB Bulletin, (Summer, 1974), 8 - 13.

Article examines various components of a successful newspaper collection scheme: generation rates, marketing arrangements and market value, collection models, program planning, public education techniques, ordinances, and designs for containers and vehicles. A list of five cost-reducing recommendations is offered. Conclusion points out the advantages of reclamation and the need for more data. (6 pp.)

"Source Separation ... A Resource Recovery Option," NCRB Bulletin, (Winter, 1977), 3 - 10.

Approaching source separation as a low-technology option where mechanical resource recovery systems are not economically feasible, article looks at economics, collection vehicle methods, socio-economic status, and scavenging. Analyzes the programs in Somerville and Marblehead, Massachusetts, and mentions many other U.S. programs for illustrative purposes. (8 pp.)

Stearns, Robert P. and Davis, Robert H., SCS Engineers Inc. The Economics of Separate Refuse Collection. Long Beach, California, undated.

Paper gives a brief history of separate newspaper collections and pinpoints projected pulp shortages in the U.S. as a reason for paper reclamation. Summarizes findings of a small household study and twenty-two case study communities. Separate truck and rack systems are contrasted for costs, equipment, volumes, revenues, crew size, performance, and participation rate. Several adapted models are used to illustrate the interaction of variables on each other under varying hypothetical conditions. Highlights the cost impacts of public vs. private collecting and disposal site ownership. Recommends choosing high SES areas for separate collection programs and points out the most successful public education activities. (9 pp.)

Sullivan, Mark and Awner, Adela. National Wildlife Federation. The Lincoln County Experience. Washington, D.C., January, 1977.

Report summarizes the month-long educational effort of the NWF's Solid Waste Project in a New England community. Includes details of public meetings and exhibits of press clippings. (37 pp.)

Tichenor, Richard. An Economic Analysis of Recycling/Incineration Systems for Lincoln County, Maine. Kittery, Maine, 1977.

Report describes a waste management system proposal based on another scheme designed by the author's non-profit company. Discusses waste generation, markets and marketing, regionalization alternatives with costs and revenues, and impacts of container legislation. (28 pp.)

Tichenor, Richard. "The Nottingham System for Resource Recovery," Compost Science, Vol. 17, No. 1 (January-February, 1976), 20-24.

Article outlines a waste incineration/reclamation system in a small New Hampshire town. Summarizing results from a more detailed study, findings are given for system acceptance, performance, costs, and revenues. (5 pp.)

Tichenor, Richard and Jansen, Edmund F. Jr. University of New Hampshire at Durham. Recycling as an Approach to Solid Waste Management in New Hampshire. Durham, New Hampshire, 1978.

Report designed to answer enquiries about an innovative waste management system developed for small communities in New Hampshire where reclamation centres are combined with incineration and/or landfill sites. While there is no formal technical or economic analysis, the report treats four topics for each system: system description, costs and revenues including cost comparisons with alternatives, experience with the system, and public education. Included are comments about ordinances, system streamlining, marketing, staffing and administration. Concludes with a useful decision-making checklist for other towns considering adapting the system for local use. (33 pp.)

Lingle, Stephen. U.S. Environmental Protection Agency. Separating Paper at the Waste Source for Recycling. Washington, D.C., 1977.

Brochure deals with source separation of residential newspaper, commercial corrugated and high-grade office paper. First section provides a historical overview of separate newspaper collection. Requirements for such collections, such as planning, capital, labour, and cost allocation are described, ending with a newspaper supply and demand forecast. (16 pp.)

U.S. Environmental Protection Agency. Resource Recovery and Waste Reduction: Fourth Report to Congress. Washington, D.C., 1977.

Chapter Four, "Source Separation for Materials Recovery", summarizes national efforts to date in the following areas: separate collection of newspaper, EPA-funded programs for both curbside collection and collection centres, office paper separation, aluminum industry recovery, and progress in mandatory source separation at federal facilities.

U.S. Environmental Protection Agency. "Materials Recovery: Solid Waste Management Guidelines for Source Separation," Federal Register, Vol. 1, No. 80 (April 23, 1976), 16950-16956.

Section of the Federal Register outlines procedures for the mandatory separation of high-grade office paper, newsprint and corrugated board, as well as for the recommended separation of metal and glass at U.S. federal installations. Cost analysis, technical operations, participant education, and marketing techniques are outlined for each fraction. (7 pp.)

Valdés-Cogliano, Sally J. League of Women Voters Education Fund. Curbing Trash: Community Guide. Washington, D.C., 1977.

Pamphlet offers a checklist for implementing local source separation programs and covers the following points: economic factors, collection systems, local ordinances, sanitation workers, communicating with key local officials, publicizing the program, and resources. Many examples are given of LWVEF activities in several U.S. cities. (6 pp.)

GLOSSARY

The following terms are defined either directly or by implication in the body of the report, but are repeated here for convenient reference:

Secondary Material: Items which have been used and are considered waste, but are kept separate from refuse or extracted from mixed refuse.

Fraction: A category of secondary material. Conventional residential fractions include the broad categories of fibre, glass, and metal cans, and the specific categories of individual paper grades, glass colours, and metal can types.

Recycling: The reprocessing of secondary material into usable form.

Processing: The preparation, through quality improvement, of secondary material for recycling, and/or the preparation, through volume reduction, of secondary material, for transport.

Market: A purchaser of secondary material. Markets include dealers who process one or more fractions, brokers who arrange transactions but do not handle materials, and users who reprocess materials.

Source Separation (Residential): The segregation of recyclable/reusable secondary material from residential refuse by the householder.

Source Separation Program (also called At-Source Recovery Program): The set of activities undertaken to recover (procure, collect, and market) segregated material. A program is operated within a specified geographical area and under the auspices of a sponsoring agent.

Collection: The process of transferring materials from individual households to a point of aggregation. There are two modes of source separate collection. In the pickup mode, a vehicle is employed to collect materials, usually placed at curbside. In the drop-off mode, residents deliver materials to a specified location.

Program Site: A location where curbside collection vehicles off-load (curbside off-load site) and/or where residents drop off materials (collection centre site). Program sites with processing and/or substantial aggregation activities, are called handling facilities. In programs with more than one site for operations, there is usually a central program site into which other sites feed.

Single- vs. Multi-Material Program: In a single-material program, only one fraction, usually newspaper or sometimes glass, is recovered. In a multi-material program, more than one fraction is recovered.

Set-Out: Segregated materials (recyclable, reusable) placed, usually at curbside, for pickup by a collection vehicle.

Collection Vehicle: A truck which picks up set-outs. Collection vehicles include vehicles such as packer trucks (which normally pickup and compact refuse), vans, and stake trucks, as well as vehicles specially designed for source separate pickup.

Single vs. Multiple Pass Collection System: The term "pass" denotes the route of a collection vehicle and all of its stops made at residences on that route. In multi-material programs, each fraction may be collected concurrently in one pass (single pass) or non-concurrently in two or more passes in which routes are repeated for each fraction (multiple pass).

Satellite System: A type of source separation program in which a number of program sites or vehicles feed a central program site or centrally dispatched vehicle.

Voluntary vs. Mandatory Source Separation: Participation in a source separation program may be a matter of individual choice (voluntary) or may be a legal obligation under local legislation.

Comingle: The act of combining two or more fractions at the household level. Comingled fractions must be separated into component parts at some later stage in the recyclable/reusable materials flow.

Contamination: Undesirable material, which, when combined with recovered material, lowers or destroys the market value of the recovered material.

Containers: Devices which hold materials. Containers range from bags and boxes at the household level, through drums, barrels, pallet boxes and various kinds of bins at the program site level, to industrial bulk-lift (roll-off and front-loading boxes) systems at any level other than that of the household.

Measurement Terms (Residential Context):

Waste Generation: The total amount of waste produced.

Waste Composition: The various categories of waste within the amount generated.

Waste Available for Recovery: The various categories of recyclable/reusable waste generated.

Recoverable Wastes: Sometimes synonymous with wastes available for recovery and sometimes adjusted to exclude amounts lost through reuse in the home, contamination, and non-participation of a proportion of generators.

Participation Rate: The proportion of actual participants to total possible participants. (Participation is the act of segregating materials for recovery.)

Recovery Rate: The proportion of recovered material to total available/recoverable material.

Diverted Disposal Rate: The proportion of recovered material to total waste generated.

Socioeconomic Status: A sociological measure which combines income, education, and occupational status.



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Assessment of

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